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Rutherford

ELECTRONICS CO.

PULSE GENERATOR
MODEL B7B

8944 LINDBLADE ST.,
CULVER CITY,
CALIFORNIA

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Serial No. B 3880

Price $5.00

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PULSE GENERATOR

MODEL B7B

GENERAL DESCRIPTION

The model B7B is a compact, lightweight, general purpose pulse generator designed to meet the rigid requirements of a great number of research and test applications. Exacting design criteria, an electron tube complement of a small number of tube types, and special duty cycle limiting circuitry to automatically protect the output tubes from life-shortening overloads insure long periods of reliable operation with a minimum of maintenance and repair problems.

The model B7B produces trains of 50 volt pulses having repetition rates to 2 megacycles, pulse delays and widths to 10,000 microseconds, rise and fall times of 15 millimicroseconds, and a permissible duty factor of up to 30% at full amplitude.

The model B7B generates these pulse trains in the following manner. (Refer to Fig. A for time relations of the various pulses.)

The oscillator section creates a continuous train of timing pulses to establish the repetition rate of the output pulse. These timing pulses are used to start delay circuitry to produce what we shall call a start pulse. The start pulse occurs at the end of a time predetermined by the pulse delay controls. The start pulse is used to form the leading edge of the output pulse and to start another delay circuit which produces a second pulse called the stop pulse. This stop pulse occurs at the end of a time predetermined by the setting of the pulse width controls and is used to form the trailing edge of the output pulse. A clamp tube, which is cut off at the time the start pulse occurs, and back on again when the stop pulse occurs, creates what is used as a fill-in pulse between the start and stop pulses. The basic output pulse is therefore created by turning the main pulse on with the start pulse, keeping it on with the fill-in pulse, and turning it off with the stop pulse.

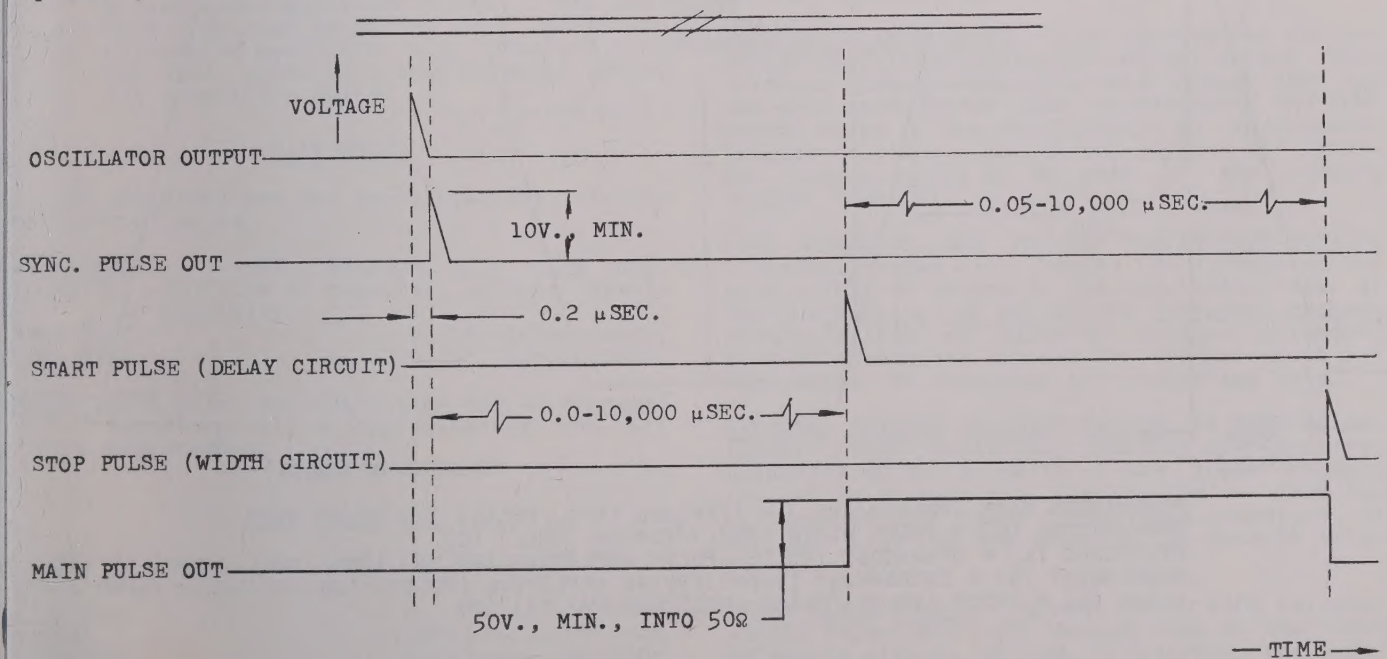


FIG. A TIMING DIAGRAM

The pulse forming circuitry then amplifies the power of this pulse and presents it through suitable attenuation and polarity determining circuitry as the main output pulse.

Supplementary circuitry furnishes a synchronizing pulse from the oscillator section for use in synchronizing additional instrumentation with the main output pulse of the generator, a means of triggering the generator from a external source so that it may be synchronized with other instruments, and a means of varying the rise and fall times of the output pulse for applications requiring a degraded pulse shape.

Past experience has indicated confusion concerning the definition of some of the basic terminology used in reference to pulses. Fig. B shows these terms as defined by accepted IRE standard pulse terminology. When used in this manual, these terms are meant to be as defined by this standard.

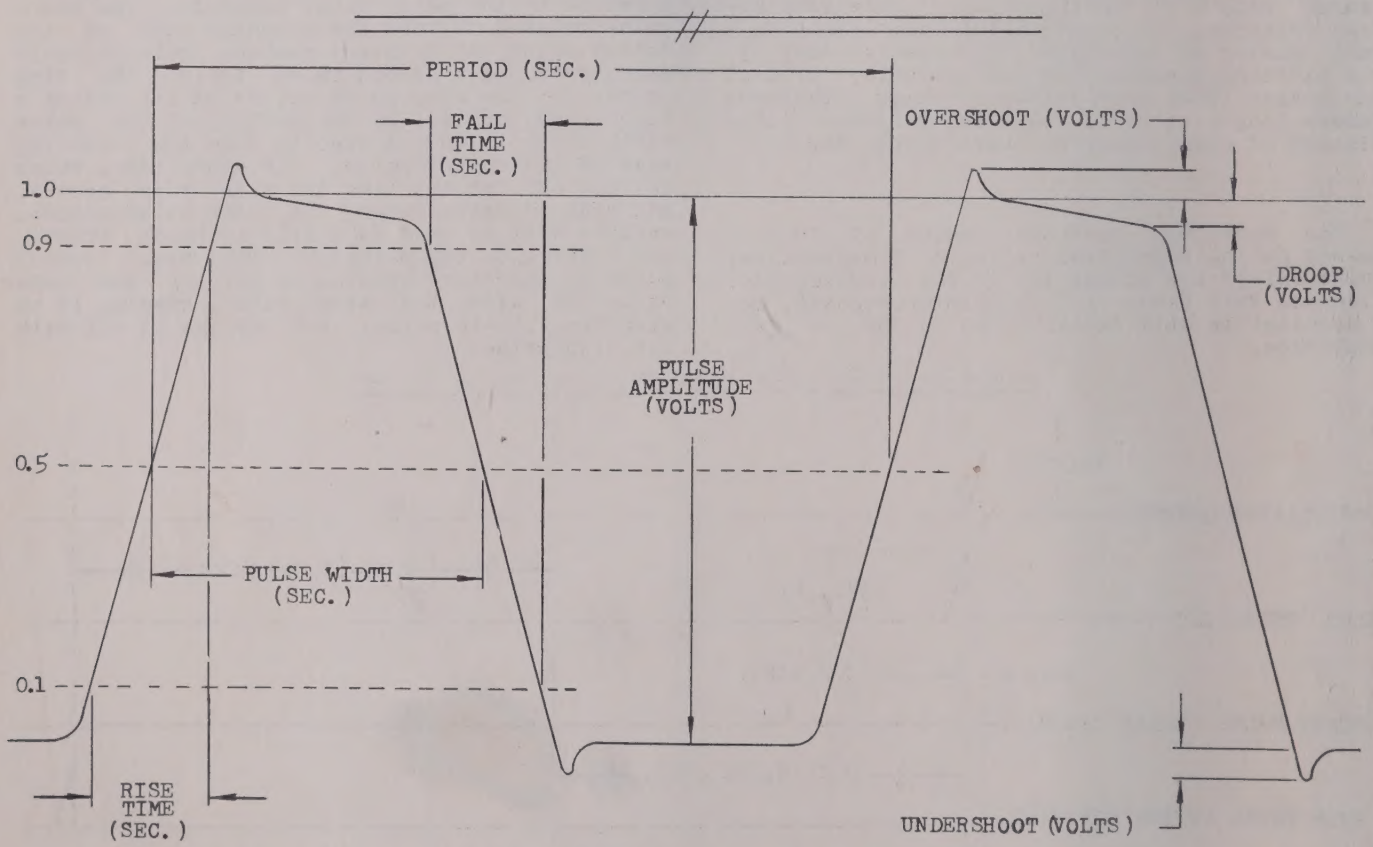
SPECIFICATIONS

The following are the design specifications of the model B7B pulse generator. The instrument will, in most cases, exhibit properties which are superior to the specifications.

OSCILLATOR REPETITION RATE

The internal oscillator is continuously variable from 20 cycles per second to 2 megacycles per second in five ranges.

20 cps	-	200 cps
200 cps	-	2 kc
2 kc	-	20 kc
20 kc	-	200 kc
200 kc	-	2 mc



REPETITION RATE (PULSES/SEC.) = 1/PERIOD (SEC./PULSE)
DUTY FACTOR (%) = PULSE WIDTH (SEC.)/PERIOD (SEC.) 100
OVERSHOOT (%) = OVERSHOOT (VOLTS)/PULSE AMPLITUDE (VOLTS) 100
UNDERSHOOT (%) = UNDERSHOOT (VOLTS)/PULSE AMPLITUDE (VOLTS) 100
DROOP (%) = DROOP (VOLTS)/PULSE AMPLITUDE (VOLTS) 100

FIG. B DEFINITIONS OF BASIC PULSE TERMINOLOGY

PULSE DELAY

Main pulse delay is continuously variable, with respect to the sync. pulse out, from 0.0 microseconds to 10,000 microseconds in five ranges.

0.0 µsec.	-	1.0 µsec.
1.0 µsec.	-	10 µsec.
10 µsec.	-	100 µsec.
100 µsec.	-	1,000 µsec.
1,000 µsec.	-	10,000 µsec.

PULSE WIDTH

Main pulse width is continuously variable from 0.05 microseconds to 10,000 microseconds in five ranges.

0.05 µsec.	-	1.0 µsec.
1.0 µsec.	-	10 µsec.
10 µsec.	-	100 µsec.
100 µsec.	-	1,000 µsec.
1,000 µsec.	-	10,000 µsec.

TRIGGER REQUIRED

To trigger the unit from an external source, the following trigger pulse is required.

AMPLITUDE	20V., minimum.
REPETITION RATE	2 mc, maximum.
RISE TIME	1.0 µsec. or less.
POLARITY	Positive or negative.

NOTE: At lower repetition rates and/or faster rise times, the instrument triggers with a much lower amplitude pulse. The fast rise time quality of the sync. pulse out allows the model B7B to be triggered from the sync. pulse from another model B7B at all repetition rates.

MAIN PULSE

The following are the specifications of the main output pulse.

AMPLITUDE	50V., minimum, into a 50Ω load.
POLARITY	Positive or negative, but not simultaneously.
RISE TIME	0.015 microseconds.
FALL TIME	0.015 microseconds.

NOTE: Both rise and fall time may be degraded simultaneously to approximately one (1) microsecond.

SYNC PULSE OUT

The following sync. pulse is available at a front panel connector.

AMPLITUDE	10V., minimum.
WIDTH	0.05 µsec., minimum.
RISE TIME	0.03 µsec., maximum.
POLARITY	Positive.
OVERSHOOT AND UNDERSHOOT	5%, maximum, except when pulse is attenuated more than 30db. with the 10db. step attenuator. 30%, maximum, at 50db. down.
DROOP:	
0-100 µsec. wide pulse	Negligible.
100-1,000 µsec. wide pulse	15%, maximum.
1,000-10,000 µsec. wide pulse	25%, maximum.
DUTY FACTOR	30%, maximum, at full amplitude.
ATTENUATION	0 to 60db., continuously variable.
OUTPUT IMPEDANCE	50Ω.

MISCELLANEOUS SPECIFICATIONS

The following are miscellaneous specifications of the instrument.

POWER REQUIRED	115V., 3.26 amps., 50-60 cps, 375 watts.
VENTILATION	Forced air.
DIMENSIONS	8 3/4" X 19 1/2" X 13".
WEIGHT, NET	42 lbs.
WEIGHT, SHIPPING	56 lbs.
ACCESSORIES INCLUDED	One instruction manual.

OPERATING INSTRUCTIONS

Refer to Fig. C for the location of all of the front panel controls described below.

FREQUENCY RANGE SWITCH When operated in the internal oscillator positions rotary switch S110 switches timing capacitors C110 through C119 in the grid circuits of V11 to determine the frequency range of the oscillator. In the external trigger position, the switch applies the external trigger pulse to the grid of the Schmitt trigger tube, V12.

FINE FREQUENCY AND TRIGGER SENSITIVITY CONTROL Potentiometer R115 varies the voltage at the grid of V11 to determine the repetition rate of the oscillator on any of the frequency ranges. During periods of external trigger operation this potentiometer becomes the trigger sensitivity control to determine the triggering level.

EXTERNAL TRIGGER POLARITY SWITCH In the two external trigger positions, positive or negative, depending on the polarity of the input signal, the switch selects the positive pulse from the external trigger tube, V10A, and transfers it through S110 to the input of the Schmitt trigger tube, V12.

DELAY RANGE SWITCH Rotary switch S200 switches timing capacitors C200 through C204 in the grid to ground circuit of V20A to determine the range of pulse delay.

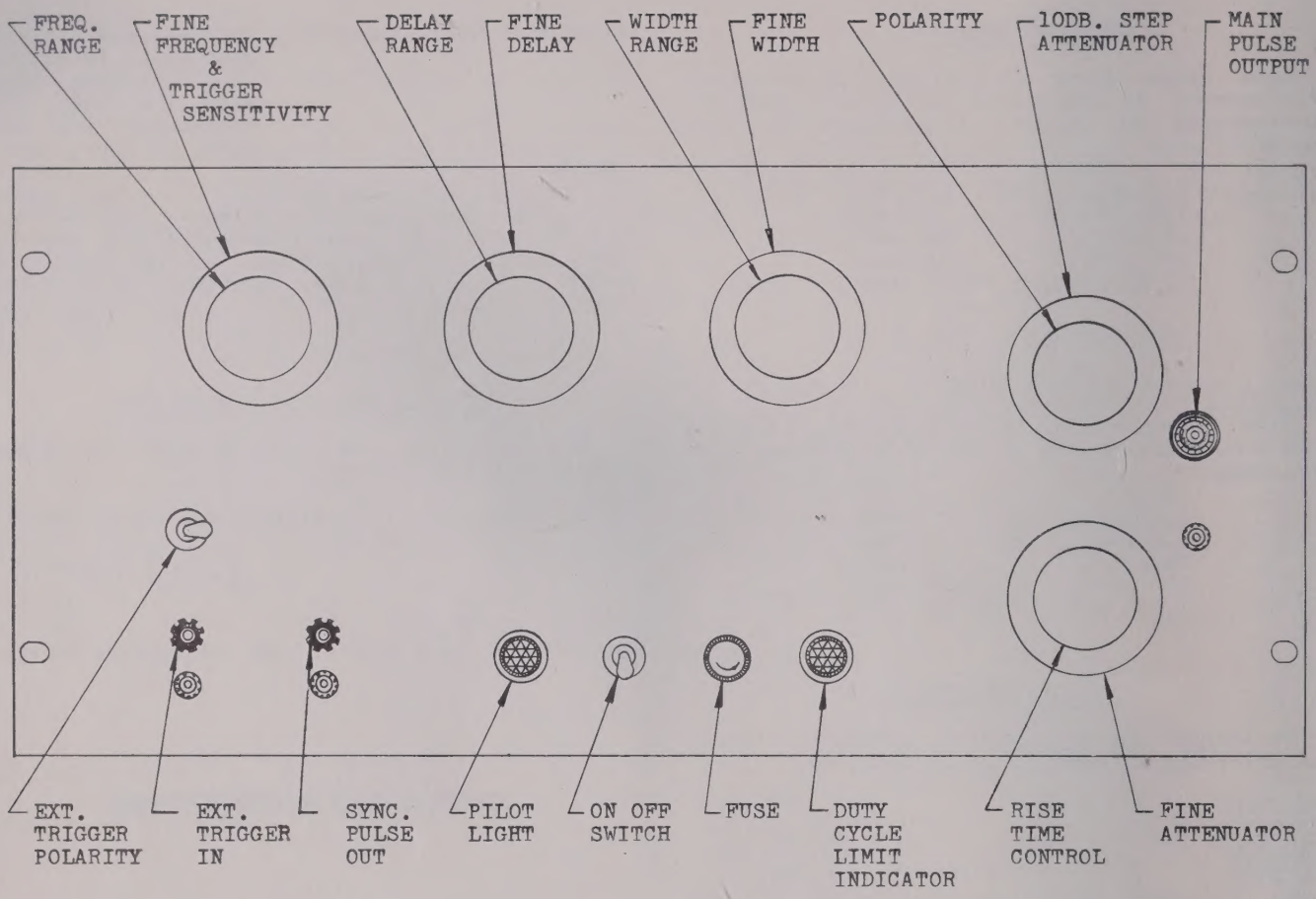


FIG. C FRONT PANEL CONTROLS

FINE DELAY CONTROL Potentiometer R208 varies the cathode to ground resistance of the pulse delay multivibrator, affording continuous delay settings on all delay ranges.

WIDTH RANGE SWITCH Rotary switch S300 switches timing capacitors C300 through C304 in the grid to ground circuit of V30A to determine the range of pulse width.

FINE WIDTH CONTROL Potentiometer R308 varies the cathode to ground resistance of the pulse width multivibrator, affording continuous width settings on all width ranges.

10db. STEP ATTENUATOR Rotary switch S800 controls the amplitude of the output pulse in 10db. steps.

FINE ATTENUATOR CONTROL Potentiometer R531 affords a continuously variable attenuation through each range of the 10db. step attenuator.

POLARITY SWITCH Rotary switch S450 determines the polarity of the output pulse by grounding various levels of the floating power supply and applying its voltages to the output tubes.

RISE TIME CONTROL Potentiometer R401 varies the resistance in the output tube control grid circuits, affording simultaneous degradation of rise and fall times to approximately one microsecond.

EXTERNAL TRIGGER IN J100 couples an external trigger through C100 to the control grid of the external trigger amplifier, V10A.

SYNC. PULSE OUT J101 takes the synchronizing pulse from the cathode of the sync. pulse cathode follower, V10B.

PILOT LIGHT Lamp DS500 lights when 115V. AC, 50-60 cps, single phase power is applied to the power transformer, T500.

ON-OFF SWITCH Switch S500 applies power to the primary winding of the power transformer, T500.

FUSE 4 ampere "slo-blo" fuse F500 protects the pulse generator from overloads.

DUTY CYCLE LIMITING INDICATOR Lamp DS530 lights when the 30% duty factor limitation is exceeded. This lamp, when lit, is a warning to the operator that the amplitude of the output pulse is being automatically reduced.

MAIN PULSE OUT Coaxial connector J800 takes the main pulse from the output of the 10db. step attenuator.

PRELIMINARY INSTRUCTIONS

VENTILATION The model B7B pulse generator is cooled by forced air. It is imperative that both ends of the instrument be kept free of obstructions at all times in order to insure adequate air flow.

It is inadvisable to operate the instrument for appreciable lengths of time with the dust covers removed. These covers not only help to keep the instrument free from dust and other foreign matter, but also properly direct the flow of air through the instrument. Therefore, if the end covers are removed and the instrument mounted in a rack, the dust cover sections must be replaced before rack mounting.

DUTY FACTOR LIMITATION The dissipation limitations of the 6DQ5 power amplifier tubes limit the duty factor of the model B7B pulse generator to 30%, i.e., at full pulse amplitude, the pulse width must never equal greater than 30% of the pulse to pulse spacing. Operation up to approximately 70% duty factor is possible with reduced pulse amplitude.

The 30% duty factor limitation is automatically controlled in the model B7B. Should the duty factor limitation be exceeded, the model B7B automatically reduces the amplitude of the output pulse to such a level that the ratings of the output tubes are not exceeded. When the duty cycle limiter is in operation, the duty cycle lamp on the front panel lights, warning the operator of the reduced pulse amplitude condition.

FIRST TIME OPERATION The following procedure is recommended for putting the instrument into operation for the first time.

1. Turn the power switch to "OFF" and connect the line cord to a source of 115V., 50-60 cps power.

2. Set the instrument controls as follows:

a.	Frequency Range	200 kc
b.	Frequency	100 kc
c.	Delay Range	1 μsec.
d.	Delay	0 μsec.
e.	Width Range	10 μsec.
f.	Width	1 μsec.
g.	10db. Step Attenuator	0 db.
h.	Fine Attenuator	0 db.
i.	Polarity	"+"
j.	Rise Time	clockwise

3. Connect a synchroscope as follows:

a.	Sweep	1 μsec./cm
b.	Vertical Deflection	20 V./cm
c.	Trigger	External from the sync. out connector on the model B7B front panel.

4. Connect a ground strap from one of the model B7B ground binding posts to a ground binding post on the synchroscope.

5. Connect a 50Ω resistive load between the pulse out connector and ground. The output impedance of the model B7B is 50Ω and it is imperative that it be properly terminated if the true output waveform is to be observed.

6. Connect the input probe of the synchroscope across the 50Ω external load. If the true waveform of the output pulse is to be observed, it is imperative that the synchroscope input probe be properly compensated for viewing step function waveforms by adjusting the compensating capacitor in the probe itself and that the probe ground strap be connected to the instrument ground.

7. Turn the model B7B power switch to "ON" and allow approximately one (1) minute for the instrument to reach operating temperature. Adjust the trigger sensitivity of the synchroscope for a stable trace. The model B7B controls may now be set to any desired values within the 30% duty factor limitation.

MAINTENANCE INSTRUCTIONS

DANGER

The power supplies in this instrument operate at voltages which are dangerous to personnel. Extreme caution must be exercised at all times. Repair or maintenance work should never be attempted unless competent personnel, thoroughly trained in the accepted methods of artificial respiration, are in attendance.

DANGER

The following maintenance suggestions are designed to aid the maintenance technician in scheduling regular preventative as well as cor-

rective maintenance routines. It is important that maintenance routines be performed regularly to obtain maximum life and usefullness from the instrument.

FAN MOTOR The fan motor bearings require oil periodically. Use a good grade of light machine oil and apply only a drop or two every six months.

CLEANING THE INSTRUMENT At regular intervals, any dust that has settled on the interior of the instrument should be removed by means of dry compressed air. AVOID high velocity air streams which might injure the instrument or disturb adjustments. Persistent dirt may be removed with a lint-free cloth and, if necessary, carbon tetrachloride.

Under normal conditions, the silver plated contacts of the rotary switches should not require special attention. In case they become tarnished, the contacts should be cleaned by rotating the switch several times.

INSPECTION A visual inspection for loose or broken wiring, loose hardware, and discolored or deformed components is desirable while the instrument is being cleaned.

SWITCHES Turn the rotary switches while observing the contacts to check contact centering in each index position. Improperly centered contacts may be due to the switch becoming warped or twisted. AVOID pressure on the contacts as they are easily damaged.

CAPACITORS AND RESISTORS Inspect the electrolytic capacitors for leakage of electrolyte. Replace if necessary. The wax coating of the paper tubular capacitors may drip if the instrument has been overheated by operation in a restricted space. This condition usually does not indicate replacement.

Composition resistors should be checked for serious discoloration which would indicate excessive dissipation and, therefore, faulty operation. A moderate amount of discoloration is normal.

RACK MOUNTING The model B7B, as purchased, is a portable instrument. It may, however, be mounted in a rack with other instrumentation by removing the louvered end panels. To remove the end panels, first remove both sections of the dust cover. The six sheet metal screws which hold each louvered end panel to the inner end panels are now accessible. Remove these screws and the two screws which hold each end panel to the front panel. Replace both dust covers on the instrument and it is ready for rack mounting. The dust covers must be put back on the instrument before rack mounting as they not only serve to keep dust and other foreign matter out of the instrument, but also help to properly direct the flow of cooling air through the instrument.

CALIBRATION The model B7B contains several controls for the purposes of calibration, pulse shape adjustment, etc. These controls are preset at the factory and should not require readjustment except due to component aging or when electron tubes are replaced.

When readjustment of these controls becomes necessary, the instrument should be allowed to operate for one hour prior to adjustment in order that all components may reach their normal operating temperatures and the instrument has reached maximum stability.

The calibration and checkout chart shown on the following page is patterned after the checkout procedure used at the factory. The chart is intended as a calibration aid only and presupposes that the instrument is in proper working order, except for calibration. It should be noted that there is some interaction between many of the controls. Therefore, it is recommended that the complete calibration and check procedure, working from top to bottom of the chart, be performed at one time on a periodic basis rather than spot adjustments to one circuit which could conceivably have adverse effect on another. Note that an asterisk (*) in any one column indicates that it does not matter which position that control is in for that particular check.

All of the controls used for calibration and adjustment are called out by schematic symbol number on the chassis or circuit board on which they are located, with the following exceptions:

C118 is mounted on the repetition rate switch.

C204 is mounted on the delay switch.

C304 is mounted on the width switch.

R602 is adjustable through the access hole at the rear of the instrument.

TROUBLE SHOOTING It is of extreme importance that the operation, theory, and physical location of components be thoroughly understood before any repair of the instrument is undertaken. A careful study of the circuit descriptions and the schematic diagram will, in most instances, indicate the cause for a particular difficulty in a much shorter time than will a blind point to point check of the entire instrument. It is also suggested that whenever an operational difficulty is encountered, a recheck of the setting and adjustment of the operational controls will often times reveal that a control has been inadvertantly set in the wrong position and that this is the cause of the difficulty.

ELECTRON TUBE FAILURE A major cause of equipment failure is weak or inoperative electron tubes. When a system failure has been traced to a particular circuit, it will be found expedient to test the electron tubes in that circuit, replacing all weak or inoperative ones, before a more detailed examination of the circuit is un-

TO CHECK OR CALIBRATE			MODEL B7B DIAL SETTINGS											OSCILLOSCOPE SETTINGS		OBSERVE	ADJUST	REMARKS
			REP. RATE		DELAY		WIDTH		ATTENUATOR		POLARITY		RISE TIME CONTROL					
			RANGE	VERNIER	RANGE	VERNIER	RANGE	VERNIER	STEP	VERNIER	OUTPUT	TRIGGER		VERTICAL	HORIZONTAL			
REP. RATE	20~-200~ 200 -2KC 2KC-20KC 20KC-200KC	HIGH END	200~-2KC	20	1	1	10	5	0	CW	*	*	CW	20V/cm	0.1millisec/cm	0.5 millisec Pulse to pulse	R111	There is some interaction between the high and low controls. Therefore, these two adjustments should be readjusted several times until both are correct. Adjustment of this range automatically adjusts the other three ranges.
		LOW END	200~-2KC	2	1	1	100	5	0	CW	*	*	CW	20V/cm	1 millisec/cm	5 millisec Pulse to pulse	R116	
	200KC-2MC		200KC-2MC	20	1	MIN	1	MIN	0	CW	*	*	CW	20V/cm	0.1µsec/cm	0.5µsec Pulse to pulse	C118	This adjustment is to be made only after the four lower ranges have been calibrated.
	EXTERNAL TRIGGER	POSITIVE	EXT. TRIG.	SEE REMARKS	1	MIN	SEE REMARKS		0	CW	*	+	CW	20V/cm	SEE REMARKS	One output pulse for each trigger in.	NONE	Use any input trigger from 20~ to 2MC rep. rate, 20V amplitude, and rise time less than 1µsec. Oscilloscope horizontal settings and B7B width setting will depend on rep. rate. Adjust B7B rep. rate vernier for reliable triggering.
		NEGATIVE	EXT. TRIG.	SEE REMARKS	1	MIN	SEE REMARKS		0	CW	*	-	CW	20V/cm	SEE REMARKS	One output pulse for each trigger in.	NONE	
	SYNC PULSE	AMPLITUDE	200KC-2MC	20	1	MIN	1	MIN	*	*	*	*	*	10V/cm	0.1µsec/cm	10V, Minimum	NONE	Looking at pulse at the sync. out jack on the instrument front panel. Polarity of the sync. pulse is positive.
		WIDTH														Approx .05µsec		
		RISE TIME														Approx .03µsec		
PULSE DELAY	1-10 10-100 100-1,000 1,000-10,000		2KC-20KC	18	10	10	1	10	0	CW	*	*	CW	20V/cm	1µsec/cm	10µsec. - leading edge of sync pulse to leading edge of output pulse.	R200	Adjustment of this range also adjusts the three remaining longer ranges.
	0 to 1		20KC-200KC	18	1	10	1	MIN	0	CW	*	*	CW	20V/cm	0.1µsec/cm	1µsec. - leading edge of sync pulse to leading edge of output pulse.	C204	This adjustment is to be made only after the four longer ranges have been calibrated. Note that when the delay vernier is CCW the output pulse occurs coincident with or before the sync. pulse.
PULSE WIDTH	1-10 10-100 100-1,000 1,000-10,000		2KC-20KC	18	1	MIN	10	10	0	CW	*	*	CW	20V/cm	1µsec/cm	10µsec. - leading edge to trailing edge of output pulse at 50% amplitude points.	R300	Adjustment of this range also adjusts the three remaining longer ranges.
	0.05 to 1		20KC-200KC	18	1	MIN	1	10	0	CW	*	*	CW	20V/cm	0.1µsec/cm	1µsec. - leading edge to trailing edge of output pulse at 50% amplitude points.	C304	This adjustment to be made only after the four longer ranges have been calibrated. Note that when the width vernier is CCW the pulse width is 0.05µsec. or less.
OUTPUT PULSE	AMPLITUDE		20~-200~	2	1	MIN	10,000	8	0	CW	+	*	CW	20V/cm	1 millisec/cm	SEE REMARKS	R473	Increase the adjustment until the amplitude of the output pulse near the trailing edge stops increasing and the leading edge starts to peak. Decrease the adjustment until the peaking just disappears.
	PULSE SHAPE	SHORT PULSE	20KC-200KC	18	1	MIN	1	5	0	CW	+	*	CW	20V/cm	0.1µsec/cm	SEE REMARKS	C260 C360 C472	Set C472 for best possible overall pulse shape. Adjust C260 and C360 for improvement. Finally, slight readjustment of all three controls will optimize the pulse shape.
		LONG PULSE	2KC-20KC	18	1	MIN	10	10	0	CW	+	*	CW	20V/cm	10µsec/cm	SEE REMARKS	C350 R354	Adjust R354 for minimum droop. Adjust C350 for optimum flatness of pulse top. Finally, slight readjustment of both controls will optimize long pulse shape.
	ATTENUATOR	10db STEP	2KC-20KC	18	1	MIN	10	10	0	CW	+	*	CW	SEE REMARKS	1µsec/cm	SEE REMARKS	NONE	The step attenuator dial should be rotated to the various dial settings while noting that pulse amplitude decreases accordingly. Change the oscilloscope vertical setting as the attenuator is changed. At high attenuation settings, good grounding between instrument and oscilloscope becomes extremely important.
		VERNIER	2KC-20KC	18	1	MIN	10	10	0	SEE REMARKS	+	*	CW	20V/cm	1µsec/cm	SEE REMARKS	SEE REMARKS	Turn attenuator vernier CCW until the output pulse decreases 10db. Pulse flatness is pre-adjusted at the factory at this setting with R353. Note, however, that R353 may be adjusted for optimum flatness at any fine attenuator (0 to 10db down) or pulse width setting. Recheck the R354 setting.
	DUTY FACTOR		200KC-2MC	20	1	MIN	1	SEE REMARKS	0	CW	+	*	CW	20V/cm	0.1µsec/cm	SEE REMARKS	R602	Set pulse width to 0.16µsec. (this is slightly in excess of 30% duty factor at 2MC). Adjust R602 to the point that pulse amplitude just starts to decrease and the duty cycle lamp on the front panel lights.
	RISE TIME	FASTEST	200KC-2MC	20	1	MIN	1	MIN	0	CW	+	*	CW	20V/cm	0.02µsec/cm	0.015µsec or less	NONE	Rise and fall times will appear to be greater than 0.015µsec. when viewed on an inferior oscilloscope. The Tektronix type N sampling unit is recommended for direct viewing of actual rise and fall times.
		DEGRADED	2KC-20KC	18			10	5					CCW		0.2µsec/cm	Approx 1µsec		
	FALL TIME	FASTEST	200KC-2MC	20	1	MIN	1	MIN	0	CW	+	*	CW	20V/cm	0.02µsec/cm	0.015µsec or less	NONE	
		DEGRADED	2KC-20KC	18			10	5					CCW		0.2µsec/cm and 5X Magnifier	Approx 1µsec		
	POLARITY	ALL OUTPUT PULSE CHARACTERISTICS SHOULD BE RECHECKED WITH THE POLARITY SWITCH IN THE "-" POSITION.																

CALIBRATION AND CHECK CHART MODEL B7B

dertaken. A HICKOCK #539A Tube Checker has been found very satisfactory in detecting electron tubes with low transconductance.

ISOLATION OF THE DEFECTIVE CIRCUIT The following trouble shooting procedure is designed to isolate the trouble to one particular circuit.

Complete failure of the instrument to operate indicates a power source difficulty. Check the source of power and make certain that the power cord plug is firmly in place. Check the fuse on the instrument front panel. A blown fuse indicates an overload condition within the instrument. Blown fuses should not be indiscriminately replaced without first ascertaining the cause of overload, as further damage is likely to result.

If power is applied to the instrument but it still fails to operate, a check should be made of the power supply voltages. For this and subsequent checks, it will be necessary to remove the dust covers from the instrument.

It will be necessary to use a synchroscope for further checks. It is important that a synchroscope with a wide band-pass be used as it is impossible to observe many of the fast rise times and narrow pulse widths on an inferior synchroscope. The Tektronix models 517, 541, 543, or 545 have been found satisfactory in observing the waveforms present in the instrument.

If the instrument has no output pulse, check for a sync. pulse at the sync. out jack on the instrument front panel. If there is no sync. pulse, the trouble is in the oscillator section of the instrument. If, however, a sync. pulse is present, synchronize a synchroscope with this pulse and proceed as follows.

Check for a pulse at the input of the attenuator switch, S800. A pulse here isolates the trouble to the switch or its components. If no pulse or a deformed pulse is present, check for a pulse at pins 3 and 6 of V40. If a normal pulse is present at this point, the faulty circuitry is in the output section.

If no pulse is present at the cathodes of V40, the trouble will probably be found in the delay multivibrator or blocking oscillator. If, however, a deformed pulse is present, a study of its shape will be helpful in quickly finding its cause.

If the deformed pulse shows a very slow rise time and normal fall time, the start pulse is missing. Check the start pulse channel. If there are very narrow pulses where the leading and trailing edges of the output pulse would normally be, the clamp circuit is inoperative. If the pulse rises normally and then immediately starts to decay slowly toward zero, the trouble lies in the clamp circuit or the width multivibrator circuit. Finally, if the pulse is normal except for a slow fall time, check the stop pulse channel for faulty operation.

In checking each subsection, it is advisable to start by looking for an output pulse from the section and then work back toward the start of the section. Thus, whenever a normal pulse is found, the trouble is isolated to the stage which immediately follows it.

CIRCUIT DESCRIPTION

OSCILLATOR SECTION The oscillator section consists of the external trigger amplifier, V10A; the free-running multivibrator, V11; the Schmitt trigger, V12; the repetition rate blocking oscillator, V13; and the sync. pulse cathode follower, V10B. V10, V11, V12, and V13 are type 6DJ8 dual triode electron tubes.

The repetition rate of the free-running multivibrator is determined by the action of two front panel controls. The range of the oscillator is determined by the selection of timing capacitors C110 through C119, in the grid circuits of V11, by the oscillator range switch, S110. Fine repetition rate control of the multivibrator, through any range, is determined by varying the fine frequency potentiometer, R115, which varies the voltage to this grid circuit.

The limits of repetition rate for each range are set with the two calibration potentiometers, R111 and R116, which establish the range through which this voltage may vary.

The output, taken from the plate of the multivibrator triggers the Schmitt trigger circuit. The Schmitt trigger circuit shapes the pulse, and sends it to the repetition rate blocking oscillator.

The repetition rate blocking oscillator again shapes the pulse. The basic repetition rate timing pulse is taken from the cathode of this blocking oscillator and is used to trigger the delay multivibrator.

The external trigger amplifier provides a means of triggering the instrument from an external source. The external trigger polarity switch, in either the positive or negative position, depending on the polarity of the input signal, couples the positive pulse from V10A through the repetition rate range switch, S110, to the input grid of the Schmitt trigger. Potentiometer R115 now becomes a trigger sensitivity control to set the triggering level. It should be noted that the repetition rate switch, S110, must be placed in the external trigger position in order to trigger the model B7B from an external source.

The timing pulse taken from the cathode of the repetition rate blocking oscillator is also coupled through a 0.2 μsec. delay line to the

grid of the sync. pulse cathode follower. The pulse taken from the cathode is brought to the instrument front panel to be used as a synchronizing pulse for use with other instrumentation. Due to the fact that the sync. pulse occurs approximately 0.2 μsec. after the pulse which triggers the pulse delay circuit, we are able to overcome the inherent delay of the remaining circuitry and can thus produce output pulses which are not delayed in time with respect to the sync. pulse.

DELAY SECTION The delay section consists of the delay multivibrator, V20, and the delay blocking oscillator, V21. V20 is a type 6DJ8 dual triode electron tube and V21 is a type 6BQ7A dual triode electron tube.

The monostable multivibrator, V20, is triggered from its stable state to its quasi-stable state by positive pulses from the oscillator section which are coupled into the grid of V20B and the plate of V20A through diode CR201. The length of time which the multivibrator remains in this quasi-stable state, determined by the timing capacitor in the grid circuit of V20A and the cathode to ground resistance of V20, is the delay time of the circuit. Thus, this circuit determines the time between the oscillator section timing pulse and the start of the main pulse.

The range of delay is determined by the selection of timing capacitors C200 through C204 by the delay range switch, S200. Fine delay control throughout any range is determined by varying the cathode to ground resistance with the fine delay potentiometer, R208.

R200 sets the voltage to which the grid circuit is returned, thus providing calibration for the various ranges.

A pulse, created by the return of the multivibrator to its stable state after this predetermined delay, is coupled from the plate of V20B to trigger the delay blocking oscillator, V21.

The pulse taken from the cathode of the blocking oscillator is known as the "start pulse". This start pulse goes to the amplifiers in the start channel and to the width section where it is used to trigger the width multivibrator.

WIDTH SECTION The pulse width section consists of the width multivibrator, V30. V30 is a type 6DJ8 dual triode electron tube.

The monostable multivibrator, V30, is triggered from its stable state to its quasi-stable state by positive pulses from the delay section which are coupled into the grid of V30B and the plate of V30A through diode CR301. The length of time which the multivibrator remains in this quasi-stable state, determined by the timing capacitor in the grid circuit of V30A and the cathode to ground resistance of V30, is the delay time of this circuit. Thus, this circuit determined the time between the delay section output pulse which starts the main pulse and the width section output pulse which stops the main pulse.

The range of pulse width, is determined by the selection of timing capacitors C300 through C304 by the width range switch, S300. Fine width control throughout any range is determined by varying the cathode to ground resistance with the fine width potentiometer, R308.

R300 sets the voltage to which the grid circuit is returned, thus providing calibration for the various ranges.

Two outputs are taken from the width multivibrator. The first is the waveform taken from the plate circuit of V30B. This waveform is a negative going pulse equal in time duration to the delay time of the width multivibrator. It is coupled through C310 to the grid of the clamp tube, V35B. The second output, a pulse created by the return of the multivibrator to its stable state after the predetermined delay, is known as the "stop pulse". This stop pulse is coupled into the amplifiers in the stop channel.

START PULSE CHANNEL The start pulse channel consists of three pulse shaping amplifier stages and the leading edge forming tube. V25 and V26 are type 7119 dual triode electron tubes. V27 is a type 6BQ7A dual triode electron tube.

The start channel receives the positive start pulse from the delay section through a 0.02 microsecond delay line, DL210. This delay line delays the start pulse without delaying the stop pulse, thus allowing a minimum output pulse width of 0.05 microseconds. This pulse goes through three pulse transformer coupled amplifier stages; V25A, V25B, and V26. Pulse transformer T260 couples the amplified pulse into the grids of the leading edge forming tube, V27. This tube drives the output pulse cathode follower, in the pulse forming section, to form the leading edge of the output pulse.

STOP PULSE CHANNEL The stop pulse channel consists of three pulse shaping amplifier stages and the trailing edge forming tube. V35A is ½ of a type 6BQ7A dual triode electron tube. V36 and V37 are type 7119 dual triode electron tubes.

The stop channel receives the positive stop pulse from the width section. It is sent through three stages of transformer coupled amplification; V35A, V36A, and V36B, into the grids of the trailing edge forming tube, V37. This tube drives the output pulse cathode follower, in the pulse forming section, to form the trailing edge of the output pulse.

OUTPUT SECTION The output section consists of the clamp tube, V35B; the pulse forming cathode follower, V40; two power amplifier tubes, V45 and V46; the control grid restoration diode, V47A; and the screen grid disconnect diode,

V47B. Electron tube V35B is ½ of a type 6BQ7A dual triode, V40 is a type 7119 dual triode, V45 and V46 are type 6DQ5 power pentodes, and V47 is a type 6DJ8 dual triode.

The clamp tube receives its input from the plate circuit of V30B in the pulse width section. During the period between output pulses, it conducts fully, holding the output at the zero level. Between the start and stop pulses it is completely cut off by the signal from the width multivibrator and holds the output pulse at full amplitude.

The grids of the pulse forming cathode follower are driven positive by the leading edge forming tube, held there by the clamp tube, and driven back to their original level by the trailing edge forming tube. From the cathodes of this tube, we take the fully shaped output pulse. This pulse is coupled through the rise time control circuitry to the control grids of the power amplifiers.

The power amplifiers, connected in parallel, act as a cathode follower for a positive pulse out, and as an inverting amplifier for a negative pulse out. This is accomplished by the action of the polarity switch, S450, which switches the floating power supply voltages to the output power amplifiers as well as coupling the output pulse to the attenuator.

Triode V47A, connected as a diode, provides restoration at the control grids of the output tubes. The restoration level is adjusted by potentiometer R473. V47B, as connected, acts as the screen grid disconnect diode for the output amplifiers.

Finally, the output pulse is sent to the step attenuator, consisting of five 10db. constant impedance T-sections, and to the pulse output jack on the instrument front panel.

POWER SUPPLY SECTION The power supply section contains the power transformer, T500; V50, a type 0A2 voltage regulator tube; V51, a type 6AS7GA dual triode electron tube; V52, a type 12AX7 dual triode electron tube; V53, a type 6U8 triode-pentode electron tube, and their associated circuitry which includes two controls for varying the amplitude of the output pulse.

The power supply section furnishes five unregulated DC voltages (+250V., -4V., -8V., -18V., and -24V.), and three regulated voltages (+150V., -150V., and a positive variable voltage) from its ground reference supplies. From its floating supply it furnishes 150V. above and below a zero reference. It also furnishes filament power for all of the electron tubes in the unit.

The +150V. supply is regulated by the action of V51A and V52A. The -150V. supply is regulated by the action of the voltage regulator tube, V50.

The positive variable voltage, used in two places; as plate supply for the last stage of start pulse amplification and as plate supply for the clamp tube; furnishes a means of varying the amplitude of the output pulse. This supply is regulated by the action of V51B and V52B. Its reference, however, is set by V53B.

This reference may be varied in two ways. First, it may be varied by varying the fine attenuator, R531. Secondly, it may be varied by the action of the duty cycle limiting control consisting of the circuitry of T600 and V53A.

Transformer T600 senses the ripple voltage in the zero leg of the floating supply. This ripple voltage increases as the output power amplifiers draw more current. The bias on the control grid of V53A is set at such a level by potentiometer R602 that the ripple voltage will take control of the tube at the point where the power amplifiers are drawing rated current and change the reference to lower the variable supply voltage. Thus, the output tubes are never allowed to exceed their dissipation ratings even if the duty factor limitation is inadvertantly exceeded. At the time the variable voltage starts to decrease due to duty cycle limiting, the front panel lamp DS530, lights to warn the operator that the amplitude of the output pulse is being automatically reduced.

CIRCUIT THEORY

This section of the manual contains explanations of several basic circuits which are used in the model B7B. Inasmuch as the technician may not be totally familiar with high repetition rate pulse handling circuitry, it is felt that the inclusion of this section in the manual will lend to a more thorough understanding of the instrument.

FREE-RUNNING MULTIVIBRATOR Fig. D is a simplified circuit of a free-running multivibrator similar to that used in the oscillator section of the model B7B.

Arbitrarily assume that at any specified instant, triode section V1 is conducting fully and triode section V2 is non-conducting because the potential at its control grid is below the cut-off potential of the tube. At this instant, the plate voltage of V1 is lowered due to the current flow through V1 and R1. C2 discharges to this voltage, holding V2 cut off.

After a time determined by the discharge time of C2 through R4, the voltage potential on the grid of V2 reaches the cut-in potential of the tube. V2 starts to conduct and its plate potential drops. This drop is immediately felt at the grid of V1 across C1, driving it to cut-off. Its plate potential rises sharply and capacitor C2 charges to the new voltage, further aiding

in the conduction of V2. After the initial change, V2 steadies to a low plate voltage and C1 discharges to the cut-in potential of V1 and the cycle starts over again.

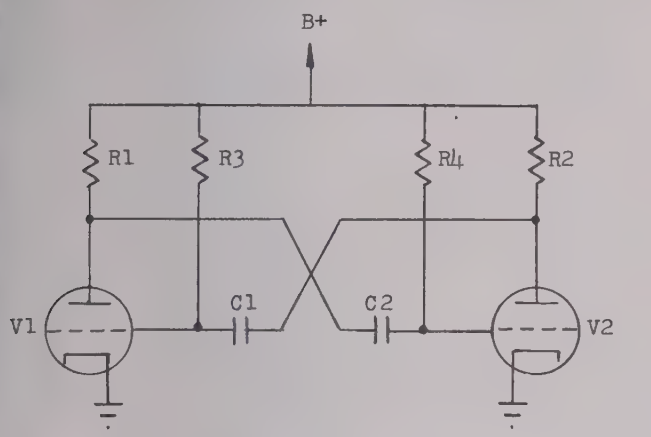


FIG. D FREE-RUNNING MULTIVIBRATOR

In summary, the operation of this circuit consists of periods of time when one tube conducts a high current while the other tube is cut off, followed by an extremely rapid change to the other tube conducting and the first tube cut off.

The repetition rate of the circuit is determined by the time constants of C1-R3 and C2-R4 and the voltage to which they are returned.

In the model B7B the range of the repetition rate of the oscillator is changed by changing the values of C1 and C2 in decade steps and the repetition rate is made continuously variable for each range by varying the level of the grid return voltage.

MONOSTABLE MULTIVIBRATOR Fig. E shows a simplified circuit of a monostable multivibrator similar to those used in the pulse delay and pulse width sections of the model B7B.

The multivibrator has one stable state and one quasi-stable state. That is, one tube section is capable of remaining in the conducting state indefinitely while the other does not have this capability. In this type of multivibrator it is necessary to trigger the circuit from its stable state to its quasi-stable state with trigger pulses from an external source. Then, the circuit will automatically return to its stable state after a certain length of time. Therefore, in operation, one triode section is triggered from non-conduction to conduction with an applied trigger. It remains in this condition for a predetermined length of time and then returns abruptly to the non-conducting state to await another trigger. Thus, we are able to generate a pulse, at a predetermined time after a given input pulse, by abruptly changing a tube section from conduction to non-conduction. Or, essentially, we have introduced a delay into the system.

Assume that the circuit is in its stable state. V1 is conducting, its grid clamped to its cathode. If R2 is made quite large, the full conduction current through V1 and thus through R6 is small and the grid is clamped near zero potential. The plate of V1, however, is at quite a low potential due to the current through the large R2. V2 is not conducting, its grid held below cut-off by the divider formed by R3, R4, and R7 between the low positive plate potential of V1 and -150 volts.

Now, at some time, a positive timing pulse arrives at the junction of the C2-R3, C3-R4 combination through diode CR1. This pulse is felt sharply across C2 and C3 at the plate of V1 and the grid of V2. V1 starts to cut off. V2 starts conducting. If R5 is small compared to R2, V2 will conduct much more heavily than V1

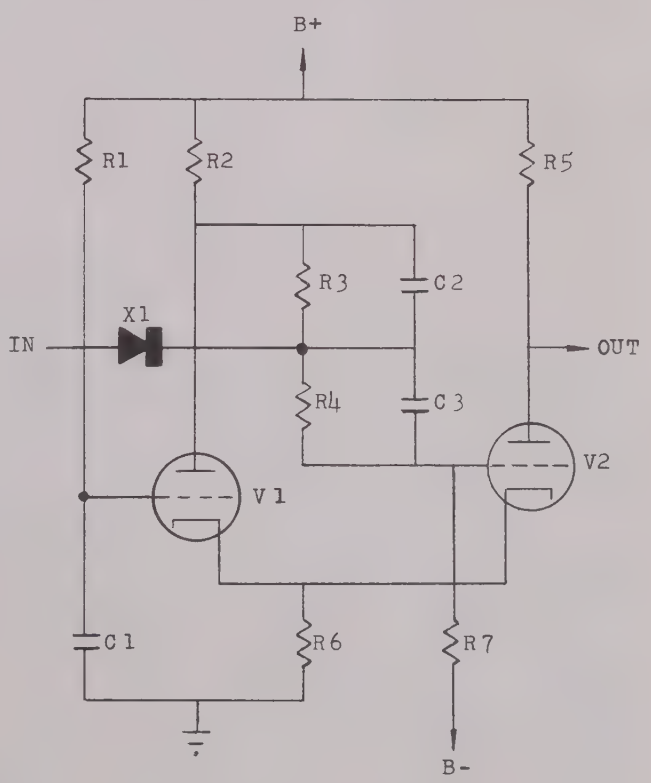


FIG. E MONOSTABLE MULTIVIBRATOR

was conducting. The drop across R6 becomes greater due to this higher current through V2, thus the cathodes raise to a higher potential. This holds V1 off completely. The plate of V1,

now at a higher potential, keeps the grid of V2 above its cut-off potential by the same divider network mentioned above. Thus, in a very short time, a trigger pulse has changed the state of the multivibrator from that of V1 conducting a small amount and V2 cut off, to one of V1 cut off and V2 conducting quite heavily.

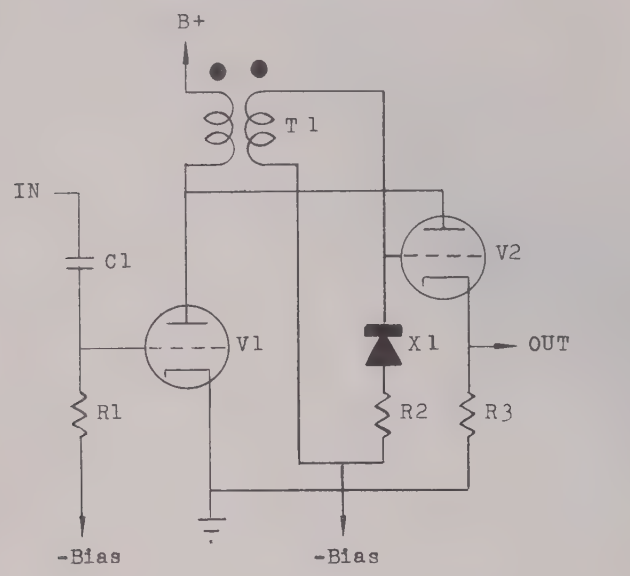


FIG. F MONOSTABLE BLOCKING OSCILLATOR

As soon as V1 is cut off by raising its cathode potential several volts with respect to its grid potential, C1 starts to charge through R1 toward the B+ potential. After a time, predetermined by the R1-C1 combination, the grid of V1 will reach cut-in potential and V1 will again start to conduct. The plate of V1 drops. This drop is felt at the grid of V2 through C2 and C3, immediately cutting off V2. The drop which cuts V2 off also drops the cathode potentials, which aids the conduction of V1. C1 discharges rapidly through the low grid to cathode resistance of V1, and the circuit has returned to its original stable state. At the transition point of V2 conducting to non-conducting, the plate waveform of V2 goes sharply positive. This waveform is taken as the output. Thus, we have produced a pulse, delayed from the original trigger pulse, by a time predetermined by R1-C1.

In the model B7B the range of delay of the pulse delay and pulse width multivibrators is changed by changing the value of C1 in decade steps. Delay and width are made continuously variable through any range by varying R6, which varies the cathode potential in the quasi-stable state, thus determining the potential which the grid must reach to cut V1 on and return the multivibrator to its stable state.

BLOCKING OSCILLATOR Fig. F shows a typical blocking oscillator circuit such as is used in the model B7B oscillator and pulse delay sections.

This blocking oscillator is a so-called monostable or driven type. That is, it is not free-running, but requires a trigger from an external source to excite it. It produces a high powered, extremely sharp, narrow pulse which is essentially independent of the shape or degradation of the pulse which triggers it.

V1 serves to amplify the input trigger and to eliminate the possibility of a reaction by the blocking oscillator back on the trigger pulse source.

In the quiescent condition, both sections of the tube are biased below cut-off. A positive trigger is coupled through C1 to the amplifier tube, V1, which inverts and amplifies it. Pulse transformer T1 inverts and applies this waveform to the grid of V2, the blocking oscillator tube. V2 conducts causing a drop in its plate voltage. The drop in plate voltage in turn causes an increase in grid voltage, which results in a further decrease in plate voltage. Due to the AC loop gain of the circuit being greater than unity, regeneration occurs. The plate drives abruptly downward and the grid abruptly upward. This action continues until such time as the loop gain drops below unity, due to the non-linearity of the tube.

The plate and grid cannot remain at the values attained by the regenerative action described above because of the low frequency characteristics of the transformer. The grid starts to drop due to its finite magnetizing inductance. When the grid voltage has dropped far enough that the loop gain once again equals unity, a regenerative action once again occurs in the direction to turn the tube off.

An overshoot occurs at the plate and grid of the tube. At the conclusion of the pulse there is still a current flowing in the magnetizing inductance of the transformer. Since this current cannot change instantaneously, it continues to flow through the effective capacitance of the transformer after the tube current has dropped to zero, causing this overshoot.

The pulse width and rise time are dependent almost entirely on the design of the transformer. The pulse transformers used in the model B7B blocking oscillators are specifically designed to produce extremely narrow, fast rise time pulses.

In the oscillator and pulse widht sections of the model B7B, blocking oscillators such as described above are used. In both of these cases, a positive pulse is taken from the cathode as the output pulse.

SCHMITT TRIGGER Figure "G" shows a typical Schmitt Trigger circuit such as is used in the Model B7B Oscillator section.

The Schmitt Trigger is a mono-stable circuit, that is, it is not free running but requires a trigger from an external source to excite it. This circuit produces an extremely sharp pulse which is essentially independent of the amplitude and waveform of the pulse which triggers it.

In the quiescent condition, V-2 is conducting, V-1 is not conducting, its grid held below cut-off by the divider network formed by R-4 and R-5 between the cathodes of V-1 and V-2 and ground. A positive trigger is coupled through C-1 to the grid of V-1 causing the tube to conduct. For an instant, the voltage across the cathode resistors increases driving the grid of V-2 towards cut-off. This, in addition with the drop-in plate voltage of V-1, causes a rapid change in V-2 from conducting to a cut-off condition. V-2 will remain cut-off until the input signal has decreased to the cut-off value of V-1. As soon as V-1 is cut off by the changing input signal, the plate voltage of V-1 will rise, causing the voltage on the grid of V-2 to rise, and V-2 conducts.

Thus, in a short time the circuit has been triggered between its two stable states by a trigger pulse whose amplitude exceeds a definite positive value and changes to a definite less positive value.

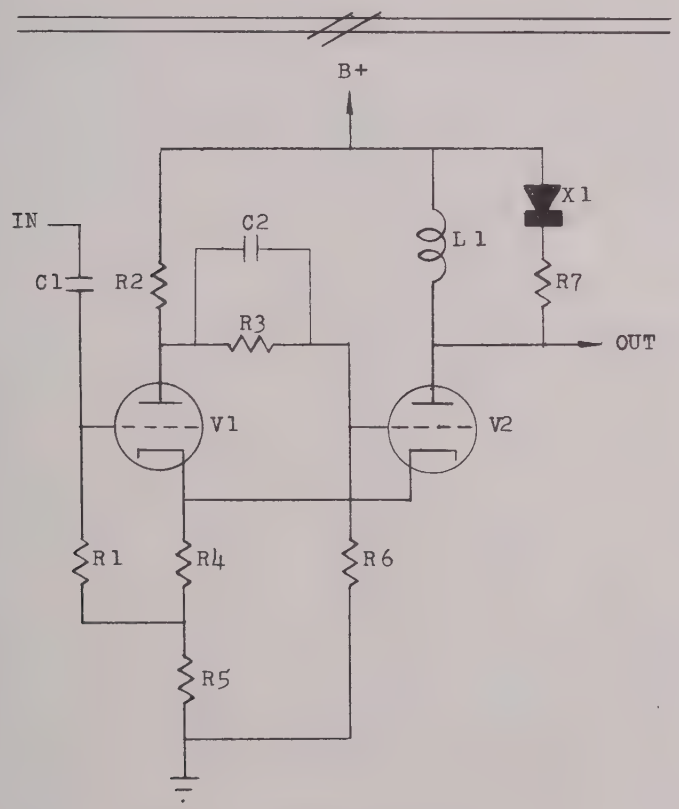


FIG. G SCHMITT TRIGGER

PARTS LIST

NOTE: Capacitors marked with an asterisk (*) are bridged and grouped to ±1% accuracy at our factory. If it becomes necessary to replace any one of these capacitors, all of the capacitors on the switch should be replaced with a set obtained through our Sales Department.

ABBREVIATIONS

cer	ceramic	k	kilohm of 10^3 ohms	prec	precision
comp	composition	m	milli or 10^{-3}	PT	paper tubular
EMC	electrolytic, metal cased	meg	megohm or 10^6 ohms	SM	silvered mica
EMT	electrolytic, metal tubular	MF	metal film	V	working volts, DC
f	farad	μ	micro or 10^{-6}	var	variable
GMV	guaranteed minimum value	μμ	micromicro or 10^{-12}	W	watt
h	henry	Ω	ohm	WW	wire wound

CAPACITORS

C100	.01 μf	fixed	cer	500V	GMV
C101	.01 μf	fixed	cer	500V	GMV
C102	.01 μf	fixed	cer	500V	GMV
C103	.01 μf	fixed	cer	500V	GMV
C104	.01 μf	fixed	cer	500V	GMV
C105	.01 μf	fixed	cer	500V	GMV
C110*	.47 μf	fixed	mylar	150V	±5%
C111*	.47 μf	fixed	mylar	150V	±5%
C112*	.047 μf	fixed	mylar	150V	±5%
C113*	.047 μf	fixed	mylar	150V	±5%
C114*	4700μμf	fixed	SM	500V	±5%
C115*	4700μμf	fixed	SM	500V	±5%
C116*	470μμf	fixed	SM	500V	±5%
C117*	470μμf	fixed	SM	500V	±5%
C118	5-80μμf	var	mica	175V	
C119	47μμf	fixed	SM	500V	±5%
C120	100μμf	fixed	cer	500V	±10%
C121	5μμf	fixed	SM	500V	±5%
C122	100μμf	fixed	cer	500V	±10%
C123	.01 μf	fixed	cer	500V	GMV
C130	100μμf	fixed	cer	500V	±10%
C131	.01 μf	fixed	cer	500V	GMV
C132	.01 μf	fixed	cer	500V	GMV
C200*	.47 μf	fixed	mylar	150V	±5%
C201*	.047 μf	fixed	mylar	150V	±5%
C202*	4700μμf	fixed	SM	500V	±5%
C203*	470μμf	fixed	SM	500V	±5%
C204	5-80μμf	var	mica	175V	
C205	.01 μf	fixed	cer	500V	GMV
C206	100μμf	fixed	SM	500V	±5%
C207	100μμf	fixed	SM	500V	±5%
C208	100μμf	fixed	cer	500V	±10%
C209	.01 μf	fixed	cer	500V	GMV
C210	100μμf	fixed	cer	500V	±10%
C211	.01 μf	fixed	cer	500V	GMV
C212	.01 μf	fixed	cer	500V	GMV
C213	.01 μf	fixed	cer	500V	GMV
C250	.01 μf	fixed	cer	500V	GMV
C260	1.5-7μμf	var	cer	500V	
C261	.01 μf	fixed	cer	500V	GMV

C300*	.47 µf	fixed	mylar	150V	±5%
C301*	.047 µf	fixed	mylar	150V	±5%
C302*	4700µµf	fixed	SM	500V	±5%
C303*	470µµf	fixed	SM	500V	±5%
C304	4-80µµf	var	mica	175V	
C306	100µµf	fixed	SM	500V	±5%
C307	100µµf	fixed	SM	500V	±5%
C308	100µµf	fixed	cer	500V	±10%
C309	2 µf	fixed	EMT	450V	-10+50%
C310	.25 µf	fixed	MP	200V	±20%
C311	.01 µf	fixed	cer	500V	GMV
C352	.01 µf	fixed	cer	500V	GMV
C351	.01 µf	fixed	cer	500V	GMV
C350	4-30µµf	var	cer	500V	
C360	4-30µµf	var	cer	500V	
C361	.01 µf	fixed	cer	500V	GMV
C362	.01 µf	fixed	cer	500V	GMV
C363	.01 µf	fixed	cer	500V	GMV
C400	.5 µf	fixed	MP	600V	±20%
C401	.01 µf	fixed	cer	500V	GMV
C402	.01 µf	fixed	cer	500V	GMV
C403	.01 µf	fixed	cer	500V	GMV
C404	.01 µf	fixed	cer	500V	GMV
C405	2 µf	fixed	EMT	450V	-10+50%
C450	20 µf	fixed	EMT	250V	-10+50%
C451	.01 µf	fixed	cer	500V	GMV
C452	33µµf	fixed	SM	500V	±5%
C453	22µµf	fixed	SM	500V	±5%
C460	20 µf	fixed	EMT	250V	-10+50%
C461	.01 µf	fixed	cer	500V	GMV
C462	33µµf	fixed	SM	500V	±5%
C470	.25 µf	fixed	MP	200V	±20%
C471	.01 µf	fixed	cer	500V	GMV
C472	9-180µµf	var	mica	175V	
C473	.01 µf	fixed	cer	500V	GMV
C474	.25 µf	fixed	MP	200V	±20%
C500	80-80 µf	fixed	EMC	350V	-10+50%
C501	80-80 µf	fixed	EMC	350V	-10+50%
C502	80-80 µf	fixed	EMC	350V	-10+50%
C503	.1 µf	fixed	PT	400V	±20%
C520	.1 µf	fixed	PT	400V	±20%
C521	2 µf	fixed	EMT	450V	-10+50%
C522	.1 µf	fixed	PT	400V	±20%
C523	2 µf	fixed	EMT	450V	-10+50%
C530	.1 µf	fixed	PT	400V	±20%
C531	.1 µf	fixed	PT	400V	±20%
C600	50 µf	fixed	EMT	25V	-10+100%
C601	200-200 µf	fixed	EMC	250V	-10+50%
C602	200-200 µf	fixed	EMC	250V	-10+50%
C603	200-200 µf	fixed	EMC	250V	-10+50%
C604	200-200 µf	fixed	EMC	250V	-10+50%
C700	1500 µf	fixed	EMC	50V	-10+50%
C801	2 µf	fixed	MP	200V	±20%
C803	.25 µf	fixed	MP	200V	±20%
C804	2 µf	fixed	MP	200V	±20%
C805	22 µµf	fixed	cer	1KV	±20%

CHOKES

L120	75µh	fixed	±10%
L200	25µh	fixed	±10%
L300	25µh	fixed	±10%

CONNECTORS

J100	Nylon Binding Post
J101	Nylon Binding Post
J800	Type SO-239

DELAY LINES

DL100	.2µsecond	fixed
DL210	.02µsecond	fixed

DIODES

CR120	(Hughes Aircraft Co. ONLY)	Type 1N116
CR130		Type 1N34A
CR200		Type 1N34A
CR201	(Hughes Aircraft Co. ONLY)	Type 1N116
CR210		Type 1N34A
CR250		Type 1N774
CR251		Type 1N774
CR300		Type 1N34A
CR301	(Hughes Aircraft Co. ONLY)	Type 1N116

CR350			Type 1N774
CR360			Type 1N774
CR361			Type 1N774
CR500	Rectifier, Silicon	200ma	360 PIV
CR501	Rectifier, Silicon	200ma	360 PIV
CR502	Rectifier, Silicon	200ma	360 PIV
CR503	Rectifier, Silicon	200ma	360 PIV
CR504	Rectifier, Silicon	200ma	360 PIV
CR505	Rectifier, Silicon	200ma	360 PIV
CR530	Rectifier, Silicon	200ma	360 PIV
CR600	Rectifier, Silicon	500ma	400 PIV
CR601	Rectifier, Silicon	500ma	400 PIV
CR602	Rectifier, Silicon	500ma	400 PIV
CR603	Rectifier, Silicon	500ma	400 PIV
CR604	Rectifier, Silicon	200ma	360 PIV
CR700	Rectifier, Silicon	200ma	360 PIV
CR701	Rectifier, Silicon	200ma	360 PIV
VR705			Type 1N2986RA

ELECTRON TUBES

V10	Type 6DJ8
V11	Type 6DJ8
V12	Type 6DJ8
V13	Type 6DJ8
V20	Type 6DJ8
V21	Type 6BQ7A
V25	Type 7119
V26	Type 7119
V27	Type 6BQ7A
V30	Type 6DJ8
V35	Type 6BQ7A
V36	Type 7119
V37	Type 7119
V40	Type 7119
V45	Type 6DQ5
V46	Type 6DQ5
V47	Type 6DJ8
V50	Type 0A2
V51	Type 6AS7GA
V52	Type 12AX7
V53	Type 6U8A

FUSE

F500	4 amperes	Slo-blo

LAMPS

DS500	#47
DS530	NE-51

RESISTORS

R100	150k	fixed	comp	½W	±10%
R101	1k	fixed	comp	½W	±10%
R102	10k	fixed	comp	½W	±10%
R103	1k	fixed	comp	½W	±10%
R104	1k	fixed	comp	½W	±10%
R105	680Ω	fixed	comp	½W	±10%
R110	1k	fixed	comp	1W	±10%
R111	10k	var	comp	2W	±20%
R112	1k	fixed	comp	1W	±10%
R113	75k	fixed	comp	½W	± 5%
R114	75k	fixed	comp	½W	± 5%
R115	10k	var	comp	2W	±20%
R116	5k	var	comp	1W	±20%
R117	4.7k	fixed	comp	2W	±10%
R120	6.8k	fixed	comp	½W	±10%
R121	470Ω	fixed	comp	½W	±10%
R122	150k	fixed	comp	½W	±10%
R123	1meg	fixed	comp	½W	±10%
R124	1.2k	fixed	comp	½W	±10%
R125	6.8k	fixed	comp	½W	±10%
R126	68k	fixed	comp	½W	±10%
R127	39k	fixed	comp	½W	±10%
R128	3.3meg	fixed	comp	½W	±10%
R130	470Ω	fixed	comp	½W	±10%
R131	1k	fixed	comp	1W	±10%
R132	1k	fixed	comp	½W	±10%
R200	100k	var	comp	1W	±20%
R201	100k	fixed	comp	½W	±10%
R202	47Ω	fixed	comp	½W	±10%
R203	470Ω	fixed	comp	½W	±10%
R204	100k	fixed	prec	½W	± 1%
R205	27k	fixed	comp	½W	±10%
R206	12k	fixed	comp	½W	±10%
R207	220Ω	fixed	comp	2W	±10%
R208	500Ω	var	comp	2W	±20%
R209	300k	fixed	comp	½W	± 5%
R210	470Ω	fixed	comp	½W	±10%
R211	3.3k	fixed	comp	½W	±10%
R212	470Ω	fixed	comp	2W	±10%
R250	1k	fixed	comp	½W	±10%
R251	150Ω	fixed	comp	½W	±10%
R252	330Ω	fixed	comp	½W	±10%
R260	1k	fixed	comp	2W	±10%
R261	1k	fixed	comp	2W	±10%

R300	100k	var	comp	1W	±20%
R301	100k	fixed	comp	½W	±10%
R302	47Ω	fixed	comp	½W	±10%
R303	470Ω	fixed	comp	½W	±10%
R304	100k	fixed	prec	½W	± 1%
R305	27k	fixed	comp	½W	±10%
R306	12k	fixed	comp	½W	±10%
R307	470Ω	fixed	comp	2W	±10%
R308	500Ω	var	comp	2W	±20%
R309	300k	fixed	comp	½W	± 5%
R350	39k	fixed	comp	½W	±10%
R351	3.3k	fixed	comp	½W	±10%
R352	330Ω	fixed	comp	½W	±10%
R353	250k	var	comp	2W	±30%
R354	50k	var	comp	2W	±30%
R355	150k	fixed	comp	½W	±10%
R356	68k	fixed	comp	2W	±10%
R357	27k	fixed	comp	½W	±10%
R360	330Ω	fixed	comp	½W	±10%
R361	330Ω	fixed	comp	½W	±10%
R400	22k	fixed	comp	2W	±10%
R401	10k	var	comp	2W	±30%
R402	3.3k	fixed	comp	2W	±10%
R450	10Ω	fixed	comp	2W	±10%
R452	47Ω	fixed	comp	½W	±10%
R453	100Ω	fixed	comp	½W	±10%
R460	10Ω	fixed	comp	2W	±10%
R462	47Ω	fixed	comp	½W	±10%
R470	1meg	fixed	comp	½W	±10%
R471	1.5k	fixed	comp	½W	±10%
R472	4.7k	fixed	comp	2W	±10%
R473	5k	var	comp	2W	±30%
R474	3.3k	fixed	comp	2W	±10%
R475	100Ω	fixed	comp	½W	±10%
R500	100k	fixed	comp	½W	±10%
R501	3k	fixed	WW	10W	±10%
R502	150k	fixed	comp	1W	±10%
R510	10Ω	fixed	comp	½W	±10%
R511	73k	fixed	prec	½W	± 1%
R512	68k	fixed	prec	½W	± 1%
R513	10Ω	fixed	comp	½W	±10%
R514	220k	fixed	comp	½W	± 5%
R515	150k	fixed	comp	½W	± 5%
R516	1500Ω	fixed	WW	25W	±10%
R520	220k	fixed	comp	½W	±10%
R521	470k	fixed	comp	½W	±10%
R522	22k	fixed	comp	2W	±10%

R530	270k	fixed	comp	½W	± 5
R531	250k	var	comp	2W	±20
R532	680k	fixed	comp	½W	±10
R533	120k	fixed	comp	½W	±10
R534	100k	fixed	comp	½W	±10
R535	6.8k	fixed	comp	2W	±10
R536	6.8k	fixed	comp	2W	±10
R600	0.75Ω	fixed	WW	5W	± 5
R601	3.3meg	fixed	comp	½W	±10
R602	50k	var	comp	1W	±30
R603	15k	fixed	comp	½W	±10
R604	100k	fixed	comp	½W	±10
R605	100k	fixed	comp	½W	±10
R700	100Ω	fixed	comp	1W	± 5
R701	160Ω	fixed	comp	2W	± 5
R702	68Ω	fixed	comp	1W	± 5
R703	68Ω	fixed	comp	1W	± 5
R704	68Ω	fixed	comp	2W	±10
R800	270Ω	fixed	MF	8W	± 5
R801	270Ω	fixed	MF	8W	± 5
R802	270Ω	fixed	MF	8W	± 5
R803	75Ω	fixed	MF	6W	± 5
R804	75Ω	fixed	MF	6W	± 5
R805	75Ω	fixed	MF	6W	± 5
R806	82k	fixed	comp	½W	±10
R807	82k	fixed	comp	½W	±10
R810	2ea 52Ω	fixed	MF	6W	± 5
R811	26Ω	fixed	MF	6W	± 5
R812	2ea 70Ω	fixed	MF	6W	± 5
R820	26Ω	fixed	MF	4W	± 5
R821	26Ω	fixed	MF	4W	± 5
R822	35Ω	fixed	MF	4W	± 5
R830	27Ω	fixed	comp	½W	± 5
R831	27Ω	fixed	comp	½W	± 5
R832	36Ω	fixed	comp	½W	± 5
R840	27Ω	fixed	comp	½W	± 5
R841	27Ω	fixed	comp	½W	± 5
R842	36Ω	fixed	comp	½W	± 5
R850	27Ω	fixed	comp	½W	± 5
R851	27Ω	fixed	comp	½W	± 5
R852	36Ω	fixed	comp	½W	± 5

SWITCHES

S100	SPDT	EXT. TRIG. POL. TOGG
S110	B7B-B-519	RUTHERFO
S200	B7B-B-520	RUTHERFO
S300	B7B-B-520	RUTHERFO

S450	B7B-B-522	RUTHERFORD
S500	SPST	"ON-OFF" TOGGLE
S800	B7B-B-521	RUTHERFORD

THERMISTOR

RT500	0.5-4Ω	25W

TRANSFORMERS

T130	B7-501	RUTHERFORD
T210	B7-501	RUTHERFORD
T250	B7-502	RUTHERFORD
T251	B7-504	RUTHERFORD
T260	B7-504	RUTHERFORD
T350	B7-502	RUTHERFORD
T360	B7-502	RUTHERFORD
T361	B7-504	RUTHERFORD
T500	B7-D-500	RUTHERFORD
T600	#45753	TRIAD

FERRITE BEAD

FB400	56-590-65/3B	FERROXCUBE
FB450	56-590-65/3B	FERROXCUBE
FB460	56-590-65/3B	FERROXCUBE

REPLACEMENT OF COMPONENTS

In the event that component replacement becomes necessary, it is strongly recommended, in order to avoid considerable delay and unnecessary expense, that such replacement components be purchased from your local electronics supplier. A large majority of the components used in the instrument are standard electronic components and little difficulty should be encountered in replacing them.

Certain components, manufactured to RUTHERFORD ELECTRONICS CO.'S specifications, may not be readily available through local suppliers. These components should be ordered from our factory.

MANUAL AND REPAIR PARTS: When ordering a manual please indicate the instrument model number and its serial number and date of original purchase. For spare parts we suggest, (1) a careful description of the part, (2) the model number and serial number of the instrument and date of original purchase. If possible, please identify parts in relation to the schematic, giving data shown on the circuit schematic diagram.

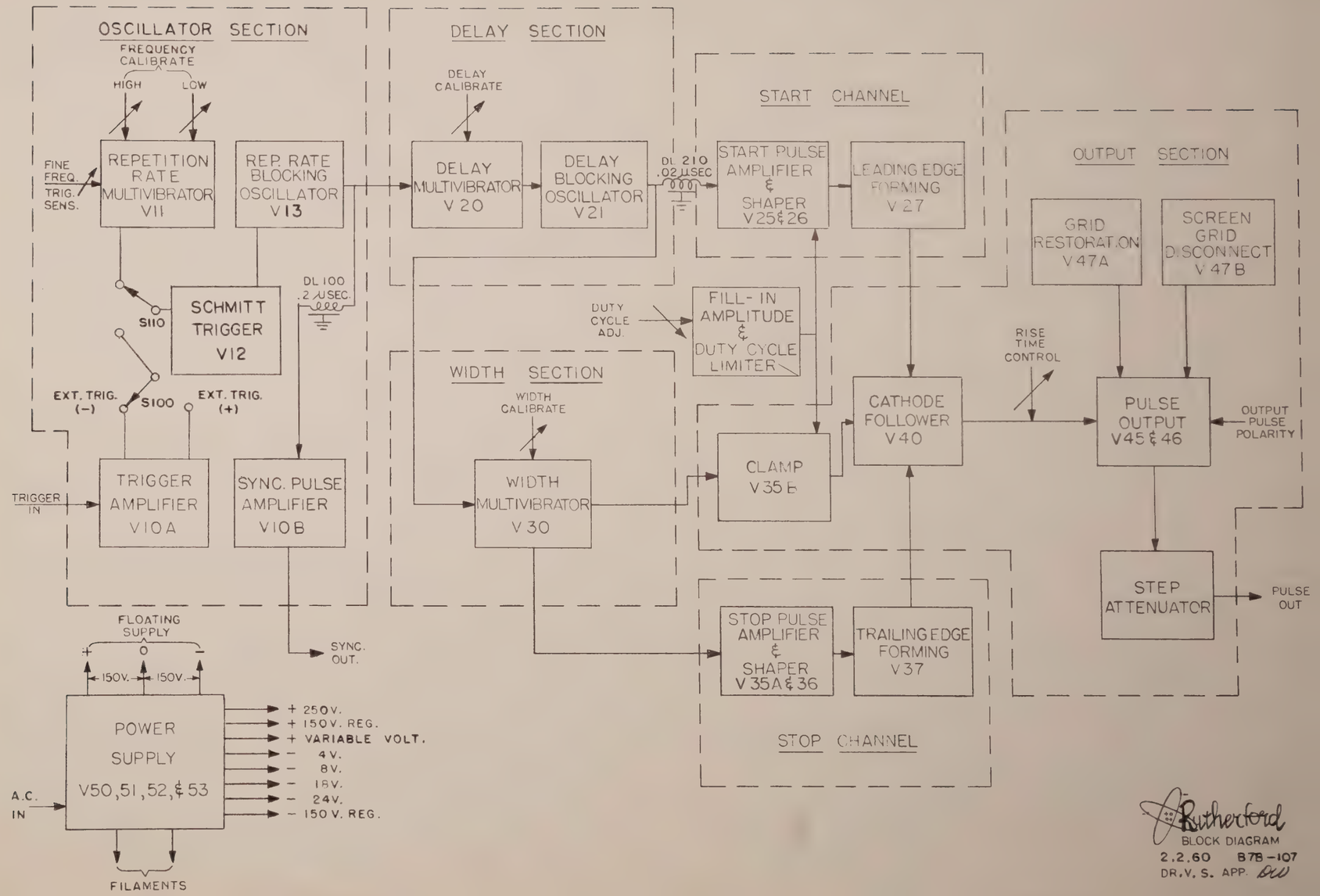
WARRANTY

RUTHERFORD ELECTRONICS CO. guarantees to the original purchaser for a period of one (1) year, EXCEPT vacuum tubes which are guaranteed for ninety days, that this instrument is free from defects in material and workmanship. Our liability is limited to repair or replacement of this instrument, or any part thereof, providing failure is not due to misuse of abnormal conditions.

In order to receive service under this warranty, promptly advise the factory of all details pertinent to failure of the instrument. Replacement parts will be shipped via air transportation if requested, prepaid to any point in the continental United States. Should it be desirable to return the instrument, ship it prepaid to the factory, and it will be serviced as required and returned via surface transportation, prepaid.

The RUTHERFORD ELECTRONICS CO. reserves the right not to honor warranty on any instrument with modifications done by the user. Before modifying, it is suggested that the modification be forwarded to the RUTHERFORD ELECTRONICS CO. for their approval, if it is desired to keep the instrument in its remaining warranty period. Send a schematic of the circuit under modification and an explanation of what will be done. In return, the RUTHERFORD ELECTRONICS CO. will evaluate your proposal and inform you as to its warranty position.

Service required after the expiration of warranty, or because of misuse or abnormal conditions will be billed at cost.



LTR	DATE	CO NO	BY

Rutherford

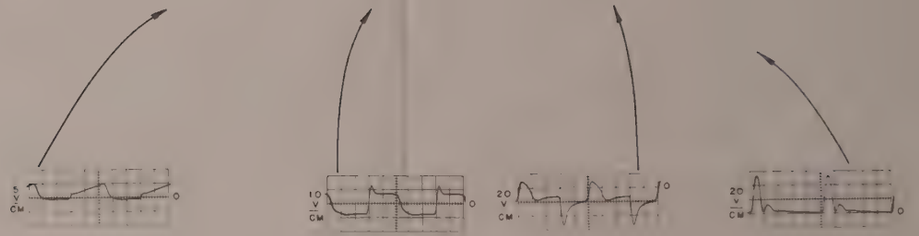
BLOCK DIAGRAM

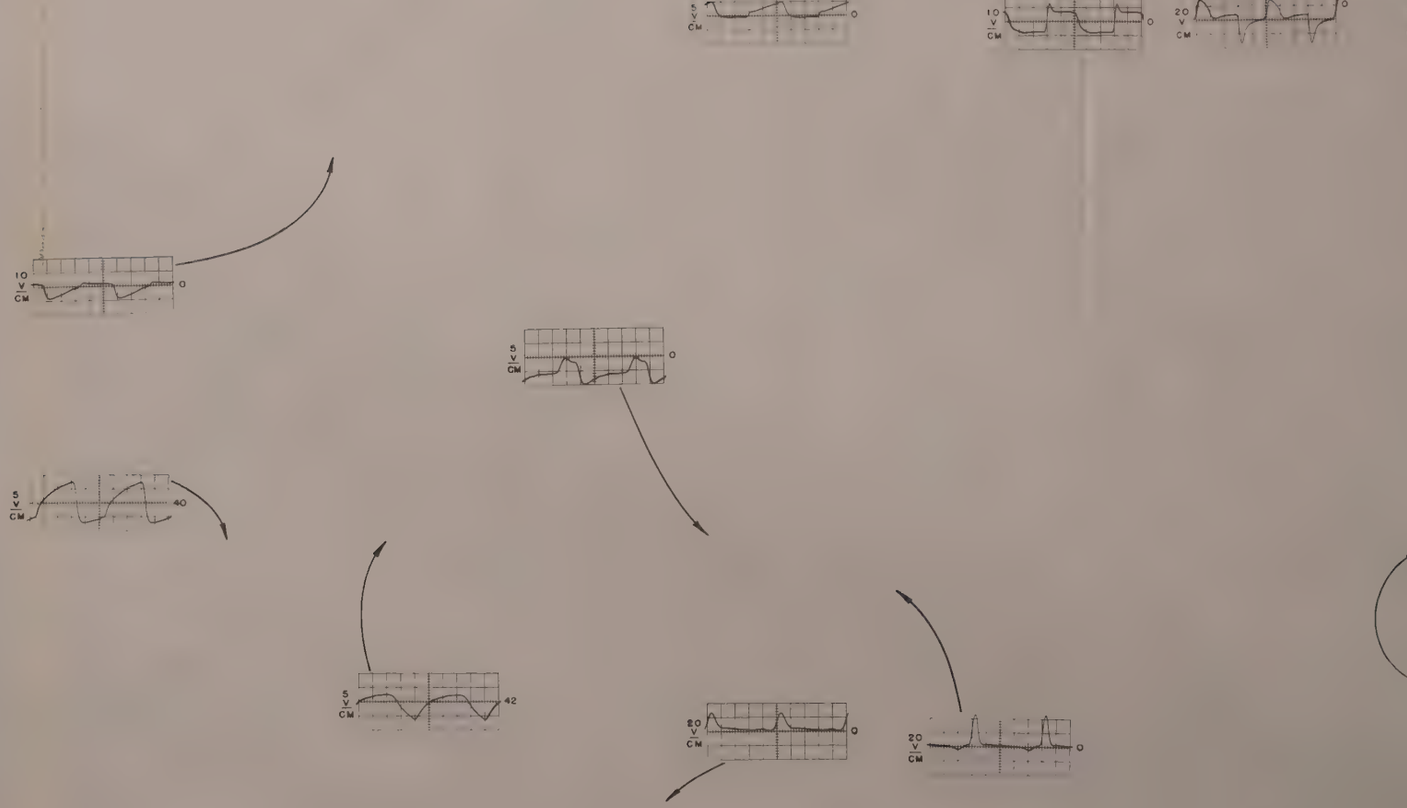
2.2.60 B78-107

DR. V. S. APP. DW

WAVEFORMS

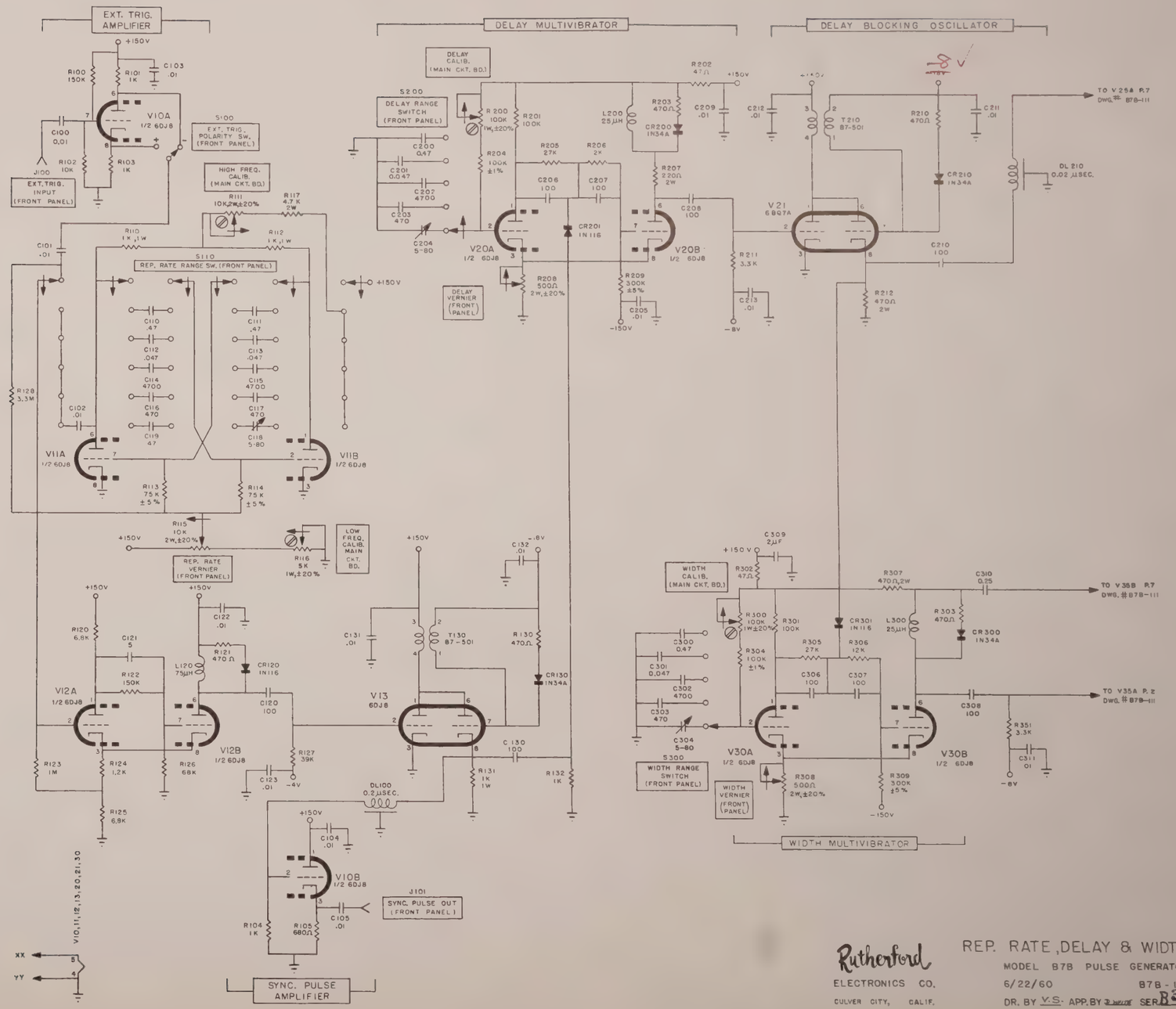
PULSE GENERATOR SETTING:	REP. RATE	2 MC
	DELAY	0.1 μSEC
	WIDTH	0.15 μSEC
OSCILLOSCOPE SETTING:	TIME/CM	0.1 μSEC
(TEKTRONIX TYPE 541A)	VOLTS/CM	AS SPECIFIED





NOTES: UNLESS OTHERWISE SPECIFIED,

1. ALL FIXED RESISTORS ARE 1/2 WATT ±10%
2. ALL CAPACITOR VALUES ONE (1) OR LESS ARE IN MICROFARADS, THOSE GREATER THAN ONE (1) ARE IN MICROMICROFARADS.



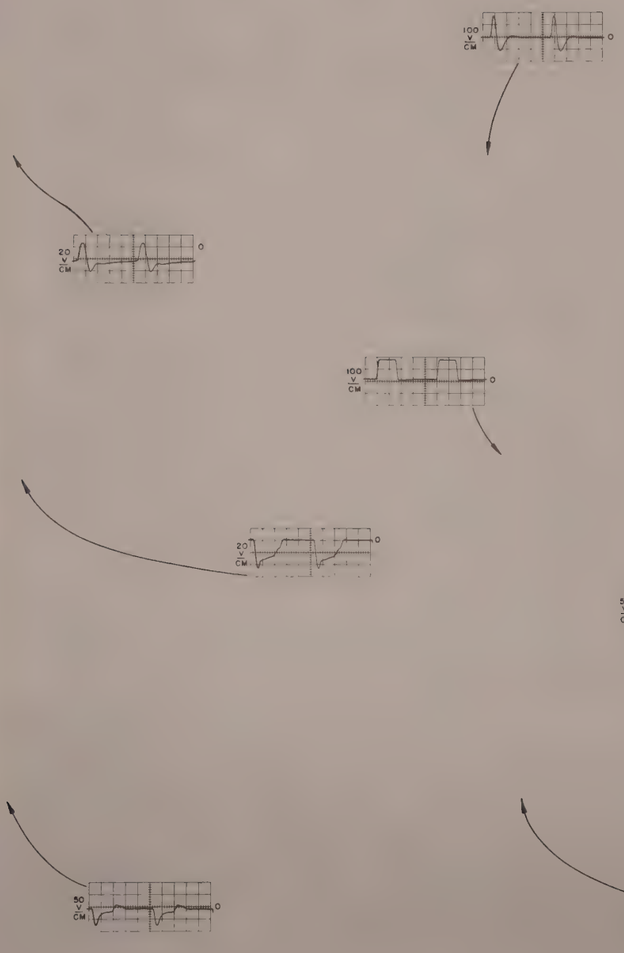
LTR	DATE	C.O. NO	BY	APP.
C	6-14-61	381	V.S.	
B	9-21-60	284	V.S.	
A	8-25-60	282	V.S.	

Rutherford ELECTRONICS CO. CULVER CITY, CALIF.

REP. RATE, DELAY & WIDTH SECT.
MODEL 878 PULSE GENERATOR
6/22/60 878-110C
DR. BY V.S. APP. BY [illegible] SER. B3880

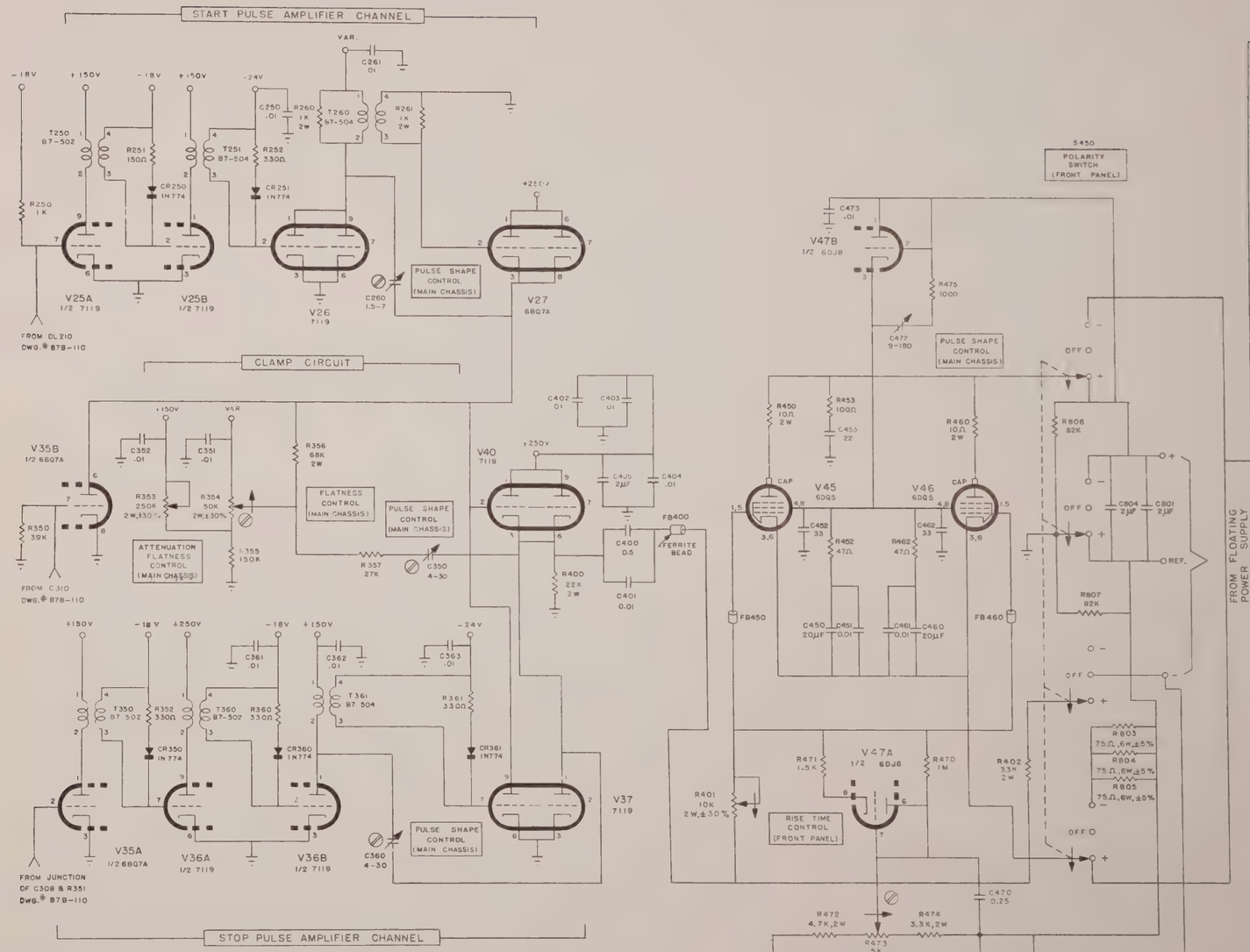
WAVEFORMS

PULSE GENERATOR SETTING:	REP. RATE	2 MC
	DELAY	0.1 μSEC
	WIDTH	0.15 μSEC
OSCILLOSCOPE SETTING:	TIME/CM	0.1 μSEC
(TEKTRONIX TYPE 541A)	VOLTS/CM	AS SPECIFIED



NOTES: UNLESS OTHERWISE SPECIFIED,

1. ALL FIXED RESISTORS ARE 1/2 WATT, ±10%.
2. ALL CAPACITOR VALUES ONE (1) OR LESS ARE IN MICROFARADS, THOSE GREATER THAN ONE (1) ARE IN MICROMICROFARADS.
3. POLARITY SWITCH, S450, SHOWN IN THE POSITIVE (+) OUTPUT PULSE POSITION.
4. STEP ATTENUATOR SWITCH, S800, SHOWN IN THE (0) DB. ATTENUATION POSITION.



LTR	DATE	C. O. NO.	BY	APP.
F	6-14-61	381	V.S.	
E	3-21-61	350	V.S.	
D	12-15-60	337	V.S.	
C	9-30-60	287	V.S.	
B	9-21-60	284	V.S.	
A	8-25-60	282	V.S.	

Rutherford
ELECTRONICS CO.
CULVER CITY, CALIF.

PULSE FORMING & OUTPUT SECT.

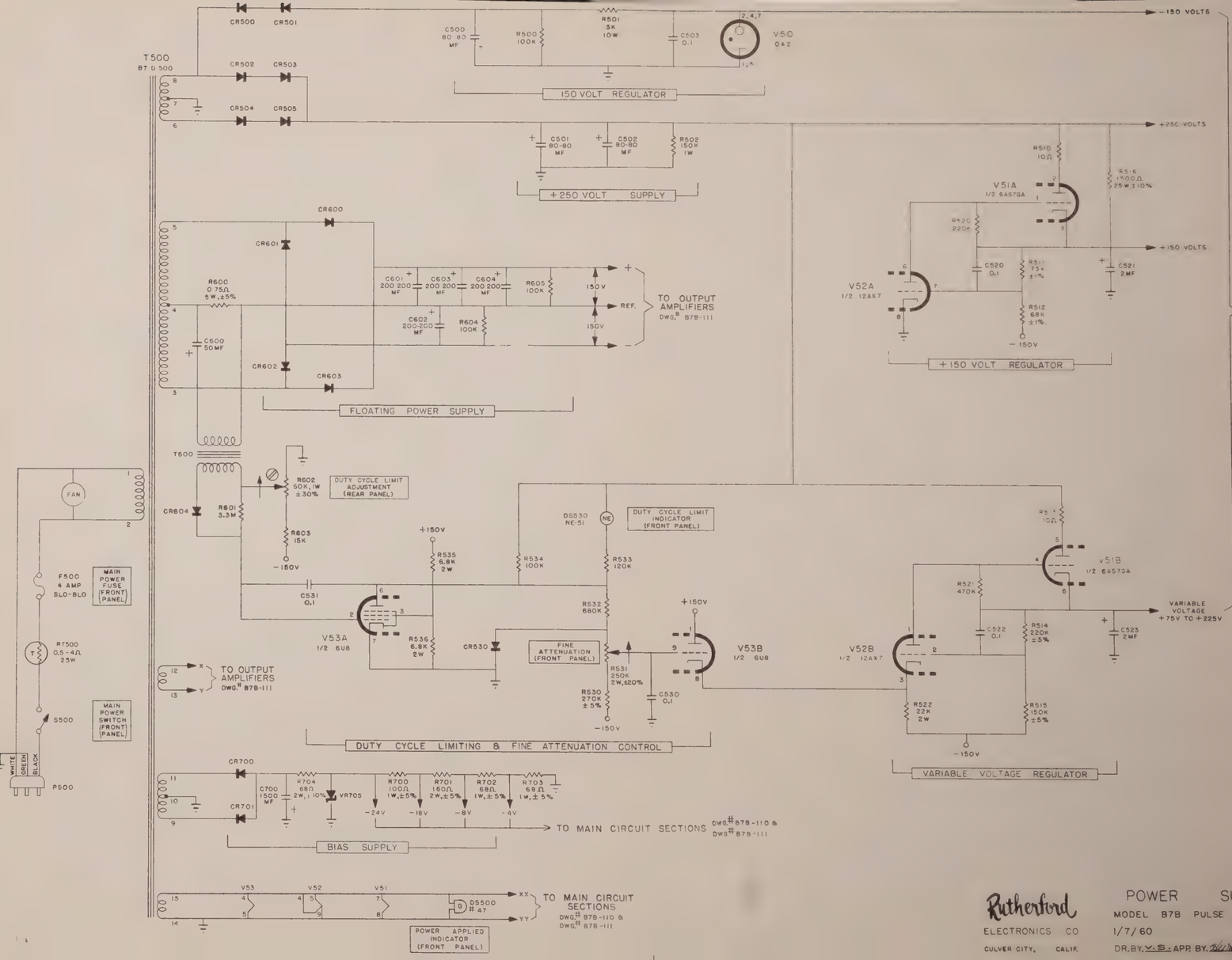
MODEL B7B PULSE GENERATOR

6/24/60 B7B-111F

DR. BY V.S. APP. BY J. WHITE SER. B3880

NOTES: UNLESS OTHERWISE SPECIFIED,

1. ALL FIXED RESISTORS ARE 1/2 WATT, ±10%.
2. ALL CAPACITOR VALUES ONE (1) OR LESS ARE IN MICROFARADS, THOSE GREATER THAN ONE (1) ARE IN MICROMICROFARADS.



CH. LTR	DATE	C.O. NO.	BY	APP.
D	8-21-61	387	V. S.	
C	6-14-61	381	V. S.	
B	12-15-60	337	V. S.	
A	8-24-60	282	V. S.	

Rutherford ELECTRONICS CO CULVER CITY, CALIF.

POWER SUPPLY
MODEL B78 PULSE GENERATOR
1/7/60 B78-104 D
DR. BY V. S. APP. BY SER. B880

Rutherford

transistorized / portable

HIGH SPEED
PULSE GENERATOR
MODEL B-10

A highly versatile, general purpose, portable pulse generator for FIELD and LABORATORY use

Featuring.... a self contained, rechargeable, battery pack, which allows independent operation "in-the-field" as well as from standard line voltage.

Rutherford ELECTRONICS CO.

8044 Lindblade Street, Culver City, California • Phone UPton 0-7393

TWX-CVR-CY-4133

SPECIFICATIONS:

Pulse Generator B-10

MAIN PULSE

Amplitude	15 Volts, min. into 50 OHM
Polarity	positive and negative
Rise Time	.020 μSEC. or less
Fall Time	.020 μSEC. or less

OSC. REPETITION RATE: The Internal Osc. is continuously variable from 20 C/S to 2 MC/S in 5 ranges.

1. 20 C/S – 200 C/S
2. 200 C/S – 2 KC/S
3. 2 KC/S – 20 KC/S
4. 20 KC/S – 200 KC/S
5. 200 KC/S – 2 MC/S

PULSE DELAY: The main pulse delay is continuously variable from 0.0 to 10,000 μSEC. in five ranges. (Referred to Sync. Pulse Out).

1. 0.0 μSEC. – 1 μSEC.
2. 1 μSEC. – 10 μSEC.
3. 10 μSEC. – 100 μSEC.
4. 100 μSEC. – 1000 μSEC.
5. 1000 μSEC. – 10,000 μSEC.

PULSE WIDTH: Main pulse width is continuously variable from 0.05 μSEC. to 10,000 μSEC. in five ranges.

1. 0.05 μSEC. – 1 μSEC.
2. 1 μSEC. – 10 μSEC.
3. 10 μSEC. – 100 μSEC.
4. 100 μSEC. – 1000 μSEC.
5. 1000 μSEC. – 10,000 μSEC.

OVERSHOOT AND UNDERSHOOT: 5% or less.

DUTY FACTOR: 60%, maximum, at full output amplitude. Duty factor limiting circuitry automatically reduces output amplitude at higher duty factors. A maximum duty factor of 90% can be achieved at reduced amplitude.

DROOP: 5%, maximum, at any width.

EXTERNAL TRIGGER: To trigger the unit from an external source the following trigger pulse is required:

Amplitude	10 Volts, Min.
Rep. Rate	2 MC/S Max.
Rise Time	0.5 μSEC. or less
Polarity	Pos. or Neg.

NOTE: At lower rep. rates and/or faster rise times, the unit triggers with a much lower amplitude pulse. The fast rise time of the sync. pulse out allows the Model B-10 to be triggered from the sync. pulse out from another B-10 at all rep. rates.

SYNC. PULSE OUT: A sync. pulse is available at a front panel connector.

1. Amplitude . 8 Volts, Min., open circuit
2. Width . . . 0.10 μSEC., Min.
3. Rise Time . . 0.05 Max.
4. Polarity . . Positive

SIZE: 8" wide, 8 ¾" high, 12" deep.

WEIGHT: 17 lbs., approximately.

POWER: 105-125 volts, AC, 50-60 cycles, 28 watts maximum. Nominal 8.5 watts from battery pack.

NOTE: From fully charged battery pack, the unit will operate for approx. 7.5 hours at 60% duty factor.

PRICE:
Less battery pack, $900.00 F.O.B. Culver City, Calif.
Complete unit, $1,080.00 F.O.B. Culver City, Calif.

Representatives and Service in the major cities of the World

All data subject to change without notice.

Bulletin No. 6

accurate research start with RUTHERFORD pulse instrumentation

Rutherford
ELECTRONICS CO.
8944 Lindblade Street
Culver City, California
Telephone: UPton 0-7393
TWX-CVR-CY-4133

pulse generators • pulse systems • accurate time delay generators

Rutherford

MODEL B9/A9

PULSE AND TIME DELAY SYSTEMS

A9-001

The Rutherford Model A9 Time Delay Systems and Model B9 Pulse Generating Systems represent a dynamic new approach to pulse and time delay circuitry. The Model A9-001 features all new transistorized circuitry, to make it the finest, most reliable, highly accurate time delay generator available today.

SPECIFICATIONS:
MODEL A9-001

DELAY: **The Model A9-001 is a highly accurate time delay generator which exhibits the following characteristics:**

RANGE: The output pulse may be delayed continuously from 0.8 to 100,000 microseconds (with respect to the input trigger) in five ranges:

0.8 microseconds to 10 microseconds
10 microseconds to 100 microseconds
100 microseconds to 1,000 microseconds
1,000 microseconds to 10,000 microseconds
10,000 microseconds to 100,000 microseconds

ACCURACY: The delay dial setting is accurate to the following tolerances, except for the 0.8 to 10 microseconds range for which no accuracy tolerance is specified:

After calibration: ± 0.1% of full scale.

JITTER: Time jitter introduced by the generator is less than 0.006% of full scale or 0.01 microseconds, whichever is greater.

DUTY FACTOR EFFECTS: Errors in delay may be introduced with increased duty factors. The table below indicates approximate error at various duty factors on the 100 to 1,000 microsecond range:

Duty Factor	Error	Duty Factor	Error
.02	Ref.	.75	3.6%
.05	1.01%	.90	5.1%
.20	0.6%	.95	6.4%
.50	2.2%		

Note: The duty factor must be limited to allow at least 3 microseconds recovery time.

LINE VOLTAGE VARIATION EFFECTS: A change of line voltage from 105 to 125 volts, RMS, changes the delay by 0.15%, maximum.

TEMPERATURE VARIATION EFFECTS: A change in ambient temperature will have the following effect on time delay:

0.8 to 10 microsecond range—a delay drift of 1% of full scale, maximum, over the range of 0°C. to +35°C.

All other ranges—a delay drift of 0.5% of full scale, maximum, over the range of −10°C. to +50°C.

MODULATION: Delay may be modulated by the introduction of an external voltage. A 2.8 to 12 volt change will vary the delay from minimum to maximum on any range.

OUTPUTS: **The following output wave forms are available at the front panel jacks.**

BLOCKING OSCILLATOR OUTPUT: The blocking oscillator output occurs at the end of the time delay setting and exhibits the following characteristics:

Amplitude: 30 volts, peak, minimum
Rise Time: .030 microseconds, maximum
Width: .1 microseconds, minimum
Polarity: Positive.
Output Impedance: 50 ohms
Blocking Capacitor: .01 microfarad

MULTIVIBRATOR OUTPUT: A multivibrator output which occurs at the end of the time delay setting is provided for conveniently viewing the delay on an oscilloscope at slow sweep speeds. It exhibits the following characteristics:

Amplitude: 12 volts, peak, minimum Width:

Delay Range	Width
0.8 to 10 microseconds	Approx. 0.5 microsecond
100 microseconds	Approx. 5 microseconds
1,000 microseconds	Approx. 36 microseconds
10,000 microseconds	Approx. 120 microseconds
100,000 microseconds	Approx. 350 microseconds

Polarity: Positive
Output Impedance: 2K ohms
Blocking Capacitor: .01 microfarad

GATE OUTPUT: A gate output is provided which turns on with the input trigger and off at the end of the time delay. It exhibits the following characteristics:

Amplitude: 10 volts, peak, minimum
Polarity: Positive
Output Impedance: 100 ohms

RAMP OUTPUT: A ramp output is provided which starts with the trigger and turns off at the end of the time delay. It exhibits the following characteristics:

Amplitude: +3 to +12 volts
Polarity: Positive—going with delay.
Output Impedance: 470 ohms

INPUT TRIGGER: **The following trigger is required from an external source to initiate the time delay.**

PULSE: The unit may be triggered by a pulse exhibiting the following characteristics:

Amplitude: 5 to 60 volts, peak
Width: 0.05 microseconds or greater
Polarity: Positive or Negative
Frequency: Single shot to 290KC
Note Duty cycle limitation

SINE WAVE: The unit may also be triggered by a sine wave exhibiting the following characteristics:

Amplitude: 10-70 volts, peak to peak
Frequency: 5 cps to 290 KC

A trigger sensitivity control allows reliable triggering from an external source, regardless of waveform.

INPUT IMPEDANCE: 50K ohms, blocking capacitor for 100 volts

MISCELLANEOUS:

POWER REQUIRED: 105 to 125 volts, 0.35 amps., 50 to 60 cps., 40 watts
WEIGHT: Approx. 55 lbs., Shipping—Approx. 60 lbs.
DIMENSIONS: 10½" high x 22" wide x 15" deep
PRICE: $1,155.00 F.O.B. Culver City, California

All data subject to change without notice.

Bulletin No. 618

Representatives and Service in the major cities of the World

Rutherford
ELECTRONICS CO.
8944 Lindblade Street
Culver City, California
Telephone: UPton 0-7393
TWX-CVR-CY-4133

accurate research start with RUTHERFORD pulse instrumentation

pulse generators / pulse systems / accurate time delay generators

Rutherford ELECTRONICS CO.
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Telephone: Upton 0-7393 • TWX CVR-CY-4133

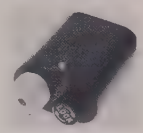
APL 860

ACCESSORY ASSEMBLIES

PRINTED IN U.S.A.
AUGUST 1, 1960

Rutherford accessories are precisely designed to enhance greater efficiency and performance, ease of operation for use in pulse instrumentation

ART NO.	DASH NO.	NAME	DESCRIPTION	PRICE
J001	–1	Extension Cable, Coax. 185 ohms (RG 114/u) Type C Connector, Both Ends	6 in. long	$17.50
	–2		10 in. long	17.50
	–3		20 in. long	17.50
	–4		24 in. long	17.50
	–5		48 in. long	19.50
	–6		96 in. long	19.50
J002	–1	Extension Cable, Coax. 185 ohms (RG 114/u) Type C Connector, One end, Open Other End	24 in. long	10.00
	–2		48 in. long	10.00
	–3		60 in. long	10.50
	–4		96 in. long	10.50
J003	–1	Extension Cable, Coax. 50 ohms (RG 58/u) Type BNC Connector, Both Ends	12 in. long	5.00
	–2		24 in. long	5.00
	–3		48 in. long	5.50
	–4		96 in. long	5.50
J004	–1	Extension Cable, Coax. 50 ohms (RG 58/u) Type BNC Connector, One End, Open Other End	12 in. long	2.50
	–2		24 in. long	2.50
	–3		48 in. long	3.50
	–4		96 in. long	3.50
J005	–1	Extension Cable, Coax. 50 ohms (RG 58/u) Type N Connector, Both Ends	24 in. long	9.50
	–2		48 in. long	10.00
	–3		96 in. long	10.00
J006	–1	Extension Cable, Coax. 50 ohms (RG 58/u) Type N Connector, One End, Open Other End	24 in. long	5.00
	–2		48 in. long	5.50
	–3		96 in. long	5.50
J007	–1	Extension Cable, Coax. 50 ohms (RG 58/u) Type UHF Connector, Both Ends	12 in. long	4.50
	–2		24 in. long	4.50
	–3		48 in. long	5.00
	–4		96 in. long	5.00
J008	–1	Extension Cable, Coax. 50 ohms (RG 58/u) Type UHF Connector, One End, Open Other End	12 in. long	2.50
	–2		24 in. long	2.50
	–3		48 in. long	3.00
	–4		96 in. long	3.00
J009	–1	Extension Cable, Coax. 93 ohms (RG 62/u) Type BNC Connector, Both Ends	12 in. long	9.00
	–2		24 in. long	9.00
	–3		48 in. long	9.50
	–4		96 in. long	9.50
J010	–1	Extension Cable, Coax. 93 ohms (RG 62/u) Type BNC Connector, One End, Open Other End	12 in. long	4.50
	–2		24 in. long	4.50
	–3		48 in. long	5.50
	–4		96 in. long	5.50

PART NO.	DASH NO.	NAME	DESCRIPTION	PRICE
J011	–1	Extension Cable, Coax. 93 ohms (RG 62/u) Type UHF Connector, Both Ends	12 in. long	4.50
	–2		24 in. long	4.50
	–3		48 in. long	5.50
	–4		96 in. long	5.50
J012	–1	Extension Cable, Coax. 93 ohms (RG 62/u) Type UHF Connector, One End, Open Other End	12 in. long	2.50
	–2		24 in. long	2.50
	–3		48 in. long	3.50
	–4		96 in. long	3.50
J014		Extension Cable, 16 Wire, Amphenol 26-4100-16P Plug, One End, 26-4200-16S Socket, Other End	40 in long. Extension Cable to be used with Model B3 and Model B5 Systems	15.00
J015		Extension Cable, 11 wire, Amphenol #86 PM11 Plug, One End, #78 PF11 Socket, Other End	24 in. long. Extension Cable to be used with Model B2 and B2A Pulse Generators	9.00
J017	–1	Adapter	Adapter, Banana Plug to Type BNC Coax. Connector, Non-Locking	6.50
	–2	Adapter	Adapter, Banana Plug to Type BNC Coax. Connector, Lock-on Type	7.50
	–3	Adapter	 Adapter, Banana Plug to Type UHF Coax. Connector, Lock-on Type	7.50
	–4	BNC Binding Post Adapter	Can be used to adapt the Single Shot Pulse Generator to the B-5A 10 MC Pulse Generator.	7.50
J018		"One-Shot" Pulse Generator	"One-Shot" Push Button Actuated Pulse Generator. Suitable for Single Pulse Operation of Model B7 Pulse Generator. 18 Volt Pulse into 470 ohms Mounts in Standard Banana Jacks	47.50
J019	–1	Air Filter End Cover	Replaces Intake End Cover on Model B7 Pulse Generator to Prevent Excessive Dust from Entering Instrument. Filter Removable for Cleaning or Replacement	18.00
	–2	Air Filter End Cover	Same as –1, Except for Model B7B Pulse Generator	18.00
J013		Mixer Assembly	"Two Input" Mixer Assembly for B3 System	55.00
J032	–1	Mixer Assembly	"Two Input" Mixer Assembly for Model B7 or B7B. Maximum Input Power Each, Input 30 Watts Average. Impedance 50 ohms	45.00
	–2	Mixer Assembly	"Three Input" Mixer Assembly for Model B7 or B7B. Maximum Input Power Each, Input 30 Watts Average. Impedance 50 ohms	60.00
	–3	Mixer Assembly	"Four Input" Mixer Assembly for Model B7 or B7B. Maximum Input Power Each, Input 30 Watts Average. Impedance 50 ohms	75.00

INSTRUCTION MANUALS

NOTE: Serial Numbers of Instrument Must Be Included When Reordering Instruction Manuals

PART NO.	DASH NO.	NAME	DESCRIPTION	PRICE
J020		Instruction Manual	For Model A2 or Model A4 Time Delay Generator	5.00
J021	–1*	Instruction Manual	For Model B2 Pulse Generator	7.50
	–2		For Model B2A Pulse Generator	7.50
J022*	–1	Instruction Manual	For Model B3 Pulse Generator	7.50
	–2		For Model B3-2 Pulse Generator	10.00
	–3		For Model B3-2A Pulse Generator	10.00
	–4		For Model B3-3 Pulse Generator	10.00
	–5		For Model B3-4 Pulse Generator	10.00
J023*		Instruction Manual	For Model B4 Time Measuring System	7.50
J024	–1*	Instruction Manual	For Model B5 Pulse Generator	7.50
	–2		For Model B5A Pulse Generator	7.50
	–3		For Model B5-2 Pulse Generator	10.00
J025	–1*	Instruction Manual	For Model B7 Pulse Generator	5.00
	–2		For Model B7B Pulse Generator	5.00
J026*		Instruction Manual	For Model D2 Calibrator	7.50
J027*		Instruction Manual	For Model G1 Pulse and Sq. Wave Generator	7.50
J028		Instruction Manual	For Model J018 "One-Shot" Pulse Generator	3.00

*Indicates Instrument No Longer In Production, But Manuals For Existing Instruments Available

INSTRUMENT MODIFICATION

PART NO.	DASH NO.	NAME	DESCRIPTION	PRICE
J029	–1		Modifies the Model B2A to Provide for External Delay and Width Modulation	115.00
	–2		Modifies the Model B2A to Provide for External Delay Modulation	65.00
J030			Modifies Model B2 to Configuration and Specification of the Model B2A	400.00
J031			Modifies Model A2 or Model A4 to Incorporate Special Delay Range Per Customer Requirement	60.00
J033			Modifies Model B5 to Model B5-A	1,000.00
J034			Modifies Model B5 to Model B5-2 Double Pulse Generator	3,073.00
J035			Modifies Model B5-A to Model B5-2 Double Pulse Generator	2,080.00
J036			Delay Cable Model B5-2	325.00

THE ACCESSORIES ARE DESIGNED TO COMPLEMENT *Rutherford* PULSE INSTRUMENTATION

NEW MODEL B7-B HIGH REPETITION RATE PULSE GENERATOR AT LOW COST, HIGH PERFORMANCE and WIDE VERSATILITY

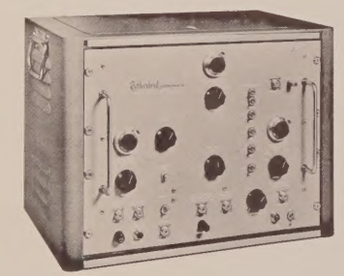
50 volts into 50 ohms at 30% duty factor . . . rep. rate to 2 mc . . . widths .05 μs to 10,000 μs . . . delays to 10,000 μs . . .

Low Budget Price . . . **$720.00**

10 MEGACYCLE PULSE GENERATOR MODEL B5-A

Featuring . . . high repetition rate with no greater than 8 millimicroseconds rise and fall time operating from 1 cps to 10 megacycles.

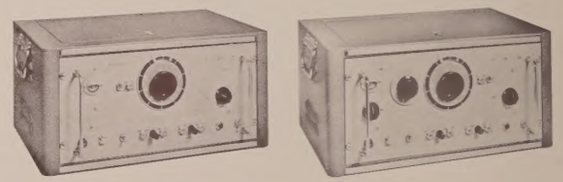
Price: **$2,400.00**



MODEL B2-A

A general purpose instrument which produces pulses of accurately controlled widths, amplitude and time delay at low impedance. Internal oscillator gives repetition rates from 10 cycles to 100 kc. Pulse widths from .08 μs to 1,000 μs.

Price: **$1,280.00**

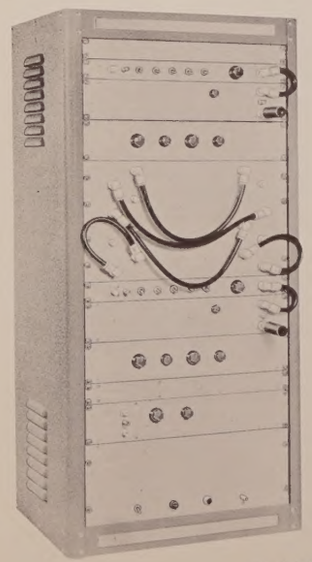


TWO TIME DELAY GENERATORS

Model A-2 **Model A-4**

Feature: Low jitter. Linear scales. Small repetition rate effects. External connector provided for delay voltage so that unit may be externally time modulated. Easily read dial controls.

Price: Model A-2 **$750.00** Model A-4 **$875.00**



HIGH SPEED 10 MEGACYCLE DOUBLE PULSE GENERATOR MODEL B5-2

Both pulse trains are derived from one single oscillator. Its output pulses are adjustable in widths from 20 mμs to 12.5 μs with rise and fall time no greater than 8 mμs. Maximum pulse width is restricted to about 20% of the pulse to pulse spacing. (Duty cycle .20 or less). Continuously variable repetition rate, pulse width and pulse delay permit the study of high speed switching circuits.

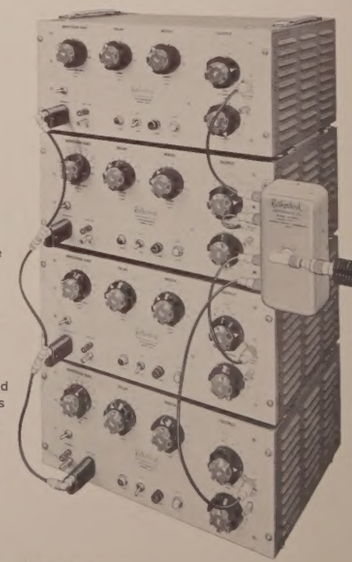
Price: **$3.975.00**

MULTI-PULSE Rutherford HIGH REPETITION RATE MULTI-PULSING SYSTEM at low cost!

4 MODEL B7-B with the use of a MIXING NETWORK produces 4 INDIVIDUAL PULSES of various specifications. The stacked units may be placed in a 19" rack type cabinet. Each of the four B7-B models can be disassembled and returned to laboratories for use as individual pulse generators.

Price: **$720.00** each.

MIXER ASSEMBLY - **$75.00**



All prices F. O. B. Culver City, California

For detailed specifications on Rutherford pulse instrumentation write for complete bulletin.

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PART NUMBERS FOR TERMINATIONS

PART NO.	CONNECTORS	IMPEDANCE	WATTAGE	PRICE	PART NO.	CONNECTORS	IMPEDANCE	WATTAGE	PRICE
K001-1	N (Male)	50 ohms	2*	35.00	K002-11	C (Male)	50 ohms	5*	40.00
K001-2	N (Male)	75 ohms	2*	37.50	K002-12	C (Male)	75 ohms	5*	42.00
K001-3	N (Male	93 ohms	2*	37.50	K002-13	C (Male)	93 ohms	5*	42.00
K001-4	N (Male)	125 ohms	2*	39.00	K002-14	C (Male)	125 ohms	5*	45.00
K001-5	N (Male)	185 ohms	2*	39.00	K002-15	C (Male)	185 ohms	5*	45.00
K001-6	N (Female)	50 ohms	2*	35.00	K002-16	C (Female)	50 ohms	5*	40.00
K001-7	N (Female)	75 ohms	2*	37.50	K002-17	C (Female)	75 ohms	5*	42.00
K001-8	N (Female)	93 ohms	2*	37.50	K002-18	C (Female)	93 ohms	5*	42.00
K001-9	N (Female)	125 ohms	2*	39.00	K002-19	C (Female)	125 ohms	5*	45.00
K001-10	N (Female)	185 ohms	2*	39.00	K002-20	C (Female)	185 ohms	5*	45.00
K001-11	C (Male)	50 ohms	2*	35.00	K003-1	N (Male)	50 ohms	10*	42.50
K001-12	C (Male)	75 ohms	2*	37.50	K003-2	N (Male)	75 ohms	10*	45.00
K001-13	C (Male)	93 ohms	2*	37.50	K003-3	N (Male)	93 ohms	10*	45.00
K001-14	C (Male)	125 ohms	2*	39.00	K003-4	N (Male)	125 ohms	10*	48.00
K001-15	C (Male)	185 ohms	2*	39.00	K003-5	N (Male)	185 ohms	10*	48.00
K001-16	C (Female)	50 ohms	2*	35.00	K003-6	N (Female)	50 ohms	10*	42.50
K001-17	C (Female)	75 ohms	2*	37.50	K003-7	N (Female)	75 ohms	10*	45.00
K001-18	C (Female)	93 ohms	2*	37.50	K003-8	N (Female)	93 ohms	10*	45.00
K001-19	C (Female)	125 ohms	2*	39.00	K003-9	N (Female)	125 ohms	10*	48.00
K001-20	C (Female)	185 ohms	2*	39.00	K003-10	N (Female)	185 ohms	10*	48.00
K002-1	N (Male)	50 ohms	5*	40.00	K003-11	C (Male)	50 ohms	10*	42.50
K002-2	N (Male)	75 ohms	5*	42.00	K003-12	C (Male)	75 ohms	10*	45.00
K002-3	N (Male)	93 ohms	5*	42.00	K003-13	C (Male)	93 ohms	10*	45.00
K002-4	N (Male)	125 ohms	5*	45.00	K003-14	C (Male)	125 ohms	10*	48.00
K002-5	N (Male)	185 ohms	5*	45.00	K003-15	C (Male)	185 ohms	10*	48.00
K002-6	N (Female)	50 ohms	5*	40.00	K003-16	C (Female)	50 ohms	10*	42.50
K002-7	N (Female)	75 ohms	5*	42.00	K003-17	C (Female)	75 ohms	10*	45.00
K002-8	N (Female)	93 ohms	5*	42.00	K003-18	C (Female)	93 ohms	10*	45.00
K002-9	N (Female)	125 ohms	5*	45.00	K003-19	C (Female)	125 ohms	10*	48.00
K002-10	N (Female)	185 ohms	5*	45.00	K003-20	C (Female)	185 ohms	10*	48.00

CONNECTORS: N (Male) = #UG 21D/U C (Male) = #UG 573A/U *1000 LFM per minute
N (Female) = #UG 23D/U C (Female) = #UG 572/U ALL DATA SUBJECT TO CHANGE WITHOUT NOTICE

PART NUMBERS FOR ATTENUATORS

PART NO.	CONNECTORS	ATTENUATORS (DB)	WATTAGE	PRICE
M001-1	N	1	4	30.00
M001-2	N	2	4	30.00
M001-3	N	5	4	30.00
M001-4	N	10	2	30.00
M001-5	N	20	1	40.00
M001-6	C	1	4	35.00
M001-7	C	2	4	35.00
M001-8	C	5	4	35.00
M001-9	C	10	2	35.00
M001-10	C	20	1	45.00
M002-1	N	1	15	45.00
M002-2	N	2	15	45.00
M002-3	N	5	10	50.00
M002-4	N	10	10	50.00
M002-5	N	20	5	60.00
M002-6	C	1	15	50.00
M002-7	C	2	15	50.00
M002-8	C	5	10	55.00
M002-9	C	10	10	55.00
M002-10	C	20	5	65.00

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